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A Compilation of Forest Biomass Harvesting and Related Policy in Canada

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BRITISH COLUMBIA

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Jean Roach and Shannon M. Berch

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Prepared by
Jean Roach
Skyline Forestry Consultants Ltd.
843 Arlington Court
Kamloops, BC V2B 8T5

Shannon M. Berch
British Columbia Ministry of Environment
Conservation Science Section
North Road Laboratory
PO Box 9536 Stn. Prov. Govt.
Victoria BC V8W 9C4

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1 INTRODUCTION

For years, the Canadian forest industry has used waste and residues from forest manufacturing processes as an energy source. According to the Office of Energy Efficiency (Natural Resources Canada 2011a), the "pulp and paper and forestry industries are Canada's major producers and users of bioenergy. In 2008, 607 MW of biomass generating capacity came from spent pulping liquor used in the pulp and paper industry. This amount represents approximately 40% of the total biomass generating capacity, while 50% of the capacity (765 MW) came from wood refuse used in the forestry industry." Now there is great interest in expanding this to include the woody material traditionally piled at the roadside and burned or left on the ground after logging. Also being considered are stands previously considered unmerchantable, residue from silviculture operations (e.g., thinning), as well as trees (e.g., hybrid poplars) grown specifically for energy production, although the latter three are not the main focus in this report. In this report, woody forest biomass primarily refers to material left after forestry operations (cull logs, small-diameter trees, undesirable species, tops, branches, and foliage). Stumps, roots, and mill residues are not included in the definition. Woody forest biomass can and is being used for supplying heat and electricity to mills or other buildings, for electricity sold to the grid, or for pellet production. The woody forest biomass resource is largely untapped in Canada, although estimating the amount of it is complex (Paré et al. 2011). Although it is abundant, bioenergy production from all urban and harvest residues would only supply an estimated 4% of the total energy used in Canada (Paré et al. 2010). Still, the interest in using forest biomass is high and is related to the following three factors: (1) Concerns about climate change and the environment are rapidly growing in Canada, and with this has come an escalating interest by government, industry, and others to at least partially replace the use of fossil fuels with alternative energy sources that create lower greenhouse gas emission levels and are renewable. These include wind, solar, tidal, and geothermal power, and agricultural and forestry biomass. (2) Developing these alternative energy sources would help diversify the Canadian energy portfolio to protect against rising fossil fuel costs and an energy crisis. (3) Development of a forest biomass harvesting industry in Canada would enhance rural development with creation of new jobs in the forestry and energy sectors, and the demand for new products is expected to help offset declining traditional markets in the struggling forest industry. There may also be advantages of woody biomass removal at the site level, such as a reduction in fire hazard, better access for tree planters, more area available for natural tree regeneration, and removal of bark beetle habitat.

Historically, many have considered woody residue as an unusable by-product of logging and it is still typically called "waste." Its presence in a managed forest was for a long time regarded as a waste of resources attributed to poor management practices, which may sometimes be the case. However, it is now widely acknowledged that a certain amount of woody debris plays an important ecological role on forest sites, with its removal having potential negative impacts on site productivity, soil nutrient and physical properties, wildlife habitat, biodiversity, and hydrology. Research on the effects of slash removal on forest ecosystems has been going on for more

than 30 years in Canada (Titus et al. 2010). There are many papers on the ecological importance of woody biomass (e.g., Harmon et al. 1986; Stevens 1997; Stewart et al. 2010). The potential impacts of whole-tree harvesting on site productivity has been a concern in Canada for several decades (Kimmins 1977). Information has been summarized recently on the impacts of intensive biomass removal on site productivity (e.g., Rauland-Rasmussen et al. 2008; Thiffault et al. 2010). Biomass removal impacts on soil physical properties (Standish et al. 1988) and biodiversity (Jonsell 2008; Berch et al. 2011) are documented and a concern. Biodiversity conservation is a significant policy issue at all levels. Numerous studies have investigated the importance of woody debris to individual species or groups of species such as fungi, invertebrates, amphibians and reptiles, birds, small mammals, carnivorous mammals, and, to a lesser degree, ungulates. Wildlife requirements for coarse woody debris (CWD) (pieces >7.5 cm in diameter) have been summarized in detail for north-central British Columbia (Keisker 2000). Impacts of biomass removal on hydrology are less documented than the importance of woody debris for soil, wildlife, and biodiversity, although the effects of conventional logging on streamflow, water quality, and snow accumulation and ablation, for instance, have been studied for years. The presence of CWD in riparian zones is also important (e.g., Bragg and Kershner 1999). There is concern over the immediate reduction in stored carbon and its transfer to emissions if forest biomass is harvested, even if the emissions are less than those of fossil fuels (Client Earth 2011). Along with ecological and environmental issues, there are other barriers to expansion of forest biomass harvesting including operational feasibility, economic viability of extracting, transporting, and processing biomass at an affordable price, and the lack of developed technology and education in Canada related to energy production from biomass. These have been discussed in a number of papers and reports (e.g., Kumar et al. 2002; Bradley 2010). A move towards extensive harvesting of woody biomass has become a topic of considerable debate (e.g., Simpson 2009).

A very important issue in discussions around the harvesting of woody forest biomass in Canada is whether existing policies and guidelines are adequate to ensure that it is harvested and used in a manner that will benefit present and future generations. The perception that woody biomass harvesting may stress forest resources if precautions are not taken suggests that guidelines may be needed to ensure that its harvesting is sustainable and that forest ecosystem health and site productivity are maintained. Forest biomass harvesting guidelines have been developed in several U.S. states, and in Europe, but what policies and guidelines are in place in Canada?

2 REPORT OBJECTIVES AND LAYOUT

The main objective of this literature review is to summarize policies, including legislation, regulations and guidelines, related to the harvest of woody forest biomass in Canada. Discussion related to other aspects of forest biomass harvesting (e.g., economics, logistics, and ecological implications) is minimal in this paper since there are other many other excellent references on these topics. The focus of the literature review is on policy that applies to Crown land, since 94% of Canada's forests are publicly owned, although a significant portion of New Brunswick and Nova Scotia's forest lands are private (Natural Resources Canada 2011b). For these provinces, policy relating to private land was searched for but information specific to biomass harvesting was lacking. The report focusses on policy related to biomass harvesting from logged blocks and roadside debris, rather than purpose-grown plantations, since this is seen as the major new forest biomass energy source (Bradley 2010), and policy relating to the latter has not been developed in Canada.

A literature search for policy-related documents was made using the Internet, and experts across the country were consulted to obtain up-to-date and undocumented information. The report first provides an overview of provincial forest biomass policy across Canada, then a description of forest biomass harvesting policy for each province and territory. A summary of Federal policies is also provided at the end of the report, although these are largely strategies and plans and not operational guidelines. The policy summaries for each province and territory begin with a brief description of the size of its forest industry and biomass resource, the land ownership breakdown, the status of the biomass harvesting industry in that jurisdiction, and the status of the province or territory in regards to development of a forest biomass harvesting policy. Policy or procedures related to allocation of biomass are described for each jurisdiction. After these sections, five general categories of policy and guidelines are summarized:

1. Energy strategies, initiatives, and policies

   Energy strategies, initiatives, and polices that promote or provide incentives for expansion of renewable/green energy sources, especially forest biomass, are summarized in this report. Some of them are actual policies in that they set out requirements for a certain amount of energy produced by the province or territory to come from renewable energy sources (although never specifically forest biomass) by a certain year. Most of them are less specific than this but still may be forces that contribute to increased use of forest biomass.

2. Policies and plans relating to sustainability

   These are policies outlining the province or territory's commitments to sustainable management of natural resources (which includes forest biomass). Some are legislation; many are not. They are included in this report because they reflect the requirements that forest biomass harvesting to be done on a sustainable basis.

3. Natural resource legislation (e.g., *Forest Acts* and regulations; also other acts such as *Environment Acts*)

   These policies legislate how Crown forests must be managed, including in a sustainable manner, for multiple uses, with requirements for forest management plans, monitoring, penalties, etc. While forest biomass is generally not specifically mentioned, it falls into the overall category of "forest products" or the like, of which there may be specific requirements. However, it is not necessarily clear how forest biomass harvesting falls into this legislation, since the laws were written when biomass harvesting was not considered a usual forestry activity. This is changing in some jurisdictions, with forest biomass now, or soon to be, addressed more specifically in policy. The amount of detail in this type of legislation varies by jurisdiction and can go as far as specifying the number of logs per hectare that must be left on a cutblock (as in British Columbia). Specifications of allowable soil disturbance levels (percentage of a cutblock that may be affected) may also be included in *Forest Acts* or regulations.

4. Operational guides

   The operational guidebooks are where many of the guidelines and recommendations for on-the-ground forestry activities are found. In some cases, the treatment options that are chosen by logging companies become mandatory once they are included in management plans. This report discusses all guidelines for removal and retention of woody debris that could be found for Canadian provinces and territories. Many guidelines, some quite detailed, exist for protection of soils, wildlife habitat, and riparian areas and, because they have direct relevance to forest biomass harvesting, are included in this report. These include guidelines for skidding operations, a primary activity in forest biomass removal from within blocks. Because the operational guidance in these books has been directed at conventional logging and not forest biomass harvesting, some guidelines may not be entirely applicable, although for many jurisdictions they are all that exist at present. Guidelines and requirements for road construction and maintenance are among the most detailed specifications in the operational manuals, but they are not discussed at any length in this report since these activities are assumed to be part of conventional forest harvesting, and done regardless of whether biomass harvesting takes place. To go into detail about requirements for all components of harvesting operations (block layout, road building, etc.) is beyond the scope of this report, even though it is recognized that biomass harvesting could take place in otherwise unlogged forests (i.e., unmerchantable or purpose-grown). Separate guidelines/policy specific to these types of biomass harvesting do not exist. Operational guidelines related to removal of biomass from silviculture treatments, such as thinning, could not be found so are also not part of the report. Operational requirements are in place for activities on landings, but these generally emphasize how to get rid of the material on site (e.g., burning of piles) so a limited amount of information is provided in this report about how to manage and remove residues on landings and roadsides. Specific guidelines or requirements for other phases of forest biomass harvesting (e.g., transport) were not found.

In addition to recommendations/guidelines provided in the guidebooks, there are scientific papers in the literature that provide recommendations that have relevance to forest biomass harvesting. For example, a particular study may recommend that disturbance should not be done within a certain distance of nesting birds. However, these papers are not policies and do not really become operational guidelines until they are published in a different format (e.g., guidebook) so they were not included in this report.

5. Protected areas legislation

   A very brief summary of legislation that dictates where logging may not be done is presented. Forest biomass harvesting is never mentioned specifically as being prohibited in parks or other protected areas, but it falls under more general categories, such as a prohibition of removal of any object from a park. These policies are included because they indicate that parts of the provinces and territories are protected from forest biomass harvesting.

3 ELEMENTS OF FOREST BIOMASS HARVESTING POLICIES

A list was compiled of elements that have been included in existing forest biomass harvesting policy/guidelines from Canada and elsewhere (e.g., Benjamin 2009; Pinchot Institute 2010; Stewart et al. 2010; Forest Guild 2012). Also included are criteria compiled by Abbas et al. (2011), who synthesized guidelines for harvesting forest biomass across North America and Europe. Some of the elements are specific to certain jurisdictions, while others are common to most. These criteria were used as a starting point when investigating policy and guidelines for each Canadian province and territory.

The main criteria in forest biomass harvesting policies that already exist are:

Sustainability

- Ecological; and
- Economic.

Operations

- Allocation of biomass;
- Working within existing forest policy, guidelines, and objectives;
- Including biomass harvesting in operating plan;
- Co-ordination with logging and site preparation activities;
- Involvement of a professional forester; and
- Monitoring and inspection of operations.

Retention and removal guidelines

- Distribution, size, species, decay classes, and amount (e.g., tonnes/ha, m^3/ha, number of pieces/ha, or percent of slash generated by logging) of post-harvest and pre-existing woody debris that must be retained; and
- Redistribution/disposal of unharvested woody biomass.

Eligible stand criteria

- Site productivity maintained;
- Protection of ecosystems with endangered, threatened, or sensitive wildlife species or plants;
- Protection of sensitive areas with high biodiversity and conservation values (e.g., wetlands, old-growth forests); and
- Protection of wildlife reserve patches.

Soil nutrients

- Harvest method restrictions (e.g., full tree harvesting prohibited on certain sites);
- Retention/distribution of tops, branches, or additional woody debris on certain sites;
- Retention of stumps and roots; and
- Retention of forest floor/litter.

Physical soil damage

- Stopping operations if damage is occurring;
- Limiting number of entries;
- Operating condition restrictions (e.g., wet soils must be frozen);
- Minimizing site damage (e.g., rutting, compaction, mineral soil exposure, and erosion);
- Design and placement of roads, skid trails, and landings to minimize soil disturbance or damage;
- Percentage of a site that can be occupied by roads, skid trails, landings, and other disturbed/damaged areas;
- Matching operating equipment and techniques to site conditions;
- Lifting rather than skidding on steep slopes; and
- Brush mats on traffic areas.

Biodiversity and wildlife

- Commitment to retain biodiversity and wildlife populations;
- Post-harvest retention of trees and snags (e.g., species, types, sizes, density, and clumpiness of trees retained);
- Retention of understorey vegetation and tree seedlings;
- Retention of small slash piles for wildlife use; and
- Buffers around dens and nests.

Riparian areas and watercourses

- Buffers around waterbodies and watercourses;
- Restrictions on debris removal and equipment traffic in buffers;
- Retention of dead and downed wood in streams, ponds, and lakes;
- Restrictions on operating conditions in buffers (e.g., only when soils are frozen);
- Keeping residue out of ditches;
- Allowing for natural drainage;
- Construction and location of skid trails and roads; and
- Contamination of streams and waterbodies with soils, chemicals, or petroleum.

Silviculture

- Damage to future crop trees;
- Re-entering areas after regeneration is established; and
- Cone retention.

Land use

- Conversion of forests to other land uses.

Social, cultural, and aesthetics

- Buffers around cultural resources.

4 OVERVIEW OF FOREST BIOMASS HARVESTING POLICY IN CANADA

Policies and guidelines relating to woody biomass harvesting are found at the provincial and territorial rather than federal level in Canada. In all Canadian provinces except Nova Scotia, New Brunswick, and Prince Edward Island, most (>89%) forested land is provincial Crown land. Federal land makes up a very small proportion of the forested land base (0–4% in all provinces except Alberta where it is 8%) (Natural Resources Canada 2011b). The direct or shared role of the Canadian Federal government in forestry is focussed on management of the limited Federal land area, science and technology, international relations, trade and investment, industrial and regional development, national statistics, climate change, protecting water, Aboriginal affairs, and environmental regulations (www.manitobawildlands.org/forests_can.htm). With the exceptions of those three provinces mentioned above, where there are significant amounts of private land, natural resources in Canada are primarily under provincial jurisdiction and so forest management policy, including that related to forest biomass harvesting, is largely a responsibility of the provinces and territories. The provinces and territories make the laws and regulations governing the use, management, and protection of the forest resource and have also developed the operational guidelines.

During the research process for this paper, it soon became apparent that, in general, the use of woody forest biomass from harvesting as an alternative energy source has much appeal in government and industry in Canada, although the biomass industry has not taken off in a big way at this point. In spite of this enthusiasm, the potential environmental, ecological, logistic, and economic concerns mentioned in the Introduction are a consistent theme brought up by these and other organizations (e.g., environmental groups). The degree to which the provinces and territories are willing to embark on the development of an ambitious new industry varies (e.g., Nova Scotia appears to be among the most conservative) and is reflected in their strategies and policies relating to forest biomass harvesting.

Appendix 1 summarizes the forest biomass harvesting policy for each province and territory. Although the territory of Nunavut has 2% of Canada's boreal forest (Canadian Boreal Initiative, www.borealcanada.ca/index-e.php), we found no information on forest biomass harvesting for Nunavut. Of all the jurisdictions, New Brunswick has the most detailed and specific biomass harvesting policy. It focusses on soils and maintenance of site productivity, and each potential biomass harvest site is evaluated to see if it meets the eligibility criteria. Ontario has a less detailed policy but does have specific rules about what can and cannot be removed from sites, and procedures related to biomass allocation. Nova Scotia also developed a policy but, because of a moratorium on using slash for electricity production, it is no longer in effect.

Quebec does not have a province-wide policy, however biomass harvesting is regulated at the regional level. In 2015 new forest management regula-

tions will be introduced, which may include more specific requirements for forest biomass harvesting. In Manitoba, biomass harvesting is also not subject to province-wide rules (opportunities are reviewed on a site-by-site basis and instructions detailed in Timber Sales Agreements and permits). Newfoundland has some basic rules regulating biomass harvesting (e.g., full tree harvesting is not permitted). In British Columbia and Alberta, forest residues are available to companies when they log a site, and biomass harvesting is regulated by existing forest management policy. New tenures in British Columbia permit access to harvesting waste not utilized by the primary harvester. Saskatchewan is actively developing a policy but details about this are not yet available.

For all of the jurisdictions, legislation and guidelines that were developed for conventional logging apply to biomass harvesting (e.g., guidelines for riparian areas and soil disturbance). For most jurisdictions, the policies and recommended procedures are entrenched in an array of different documents, which are not all in one place, making it hard to pull together all the relevant information relating to biomass policy. For example, British Columbia has a large collection of documents with guidelines relevant to forest biomass harvesting, but no central source of information.

All Canadian provinces have a framework of forest management rules and guidelines in which a commitment to sustainability is made. Indicators of sustainability include: (1) biological diversity; (2) ecosystem condition and productivity; (3) soil and water; (4) role in global ecological cycles; (5) economic and social benefits; and (6) society's responsibility (Canadian Council of Forest Ministers 2006). The provinces' commitments in natural resource policy all include sustainability of timber, soils, wildlife, biodiversity, and water in their mandate. This is a logical starting point for developing policies specific to forest biomass harvesting. However, biomass harvesting may have a greater impact on these resources than conventional logging because branches and leaves that are removed from sites have a high nutrient content, coarse woody debris needed for wildlife habitat and other uses is removed, and disturbance due to extraction of the extra woody material may damage sites to a greater degree than logging. Thus, just applying existing forest management guidelines to biomass harvesting may be insufficient to ensure that harvesting of biomass for energy is sustainable.

All jurisdictions have utilization standards for harvesting on Crown lands that specify the maximum amount of merchantable wood that may be left on a site. This tends to influence the amount of sounder, bigger pieces of the CWD population left on the ground although it does not set limits on retention of fine woody debris (pieces <7.5 cm in diameter). However, licensees may choose to leave more and be penalized, as has recently been the case in parts of the British Columbia Coast (B. Bancroft, pers. comm., Apr. 24, 2012). The minimum amount of woody biomass that needs to be left on a site is defined in a less specific way than the maximum for most provinces and the lack of specific guidelines means that the minimum amount of debris left behind tends to be left to the discretion of forest licensees or private land owners and equipment operators.

The provinces and territories all have a type of "Forest Act," which along with its regulations and associated manuals, is generally the main legislation guiding forestry practices on Crown land. These pieces of legislation include requirements for forest management plans, sustainability of the forest re-

sources, and defined utilization standards. Forest biomass harvesting per se is not currently mentioned in most of these acts but falls under the category of "forestry activities" or the like. All of the provinces have additional acts regulating forestry activities (e.g., environmental acts, wildlife acts). The acts themselves generally provide overall objectives for natural resource management and are not as specific as the regulations and manuals, which provide more operational "rules."

The degree to which the regulations and manuals are prescriptive and detailed varies among jurisdictions, with British Columbia near the head of the pack when the Forest Practices Code guidebooks were in effect. Non-legally-binding guides and other documents also direct forestry activities, and along with manuals, are the places where on-the-ground woody biomass management and harvesting recommendations are often found. All of the provinces have some sort of guidelines related to forest biomass retention and removal from logged sites, including guidance for slash distribution and piling. Consistent themes are the requirement to re-distribute unutilized slash over cutblocks and to retain residues at the stump where soils are dry, coarse-textured, and/or nutrient-poor.

Specific requirements as to sizes, species, decay classes, volume, etc. of pieces to be left on the ground are not legislated with the exception of British Columbia, which requires retention of four logs per hectare of a minimum specified size on cutblocks, and Quebec, which requires that 30% of slash be retained on the site. So, in terms of quantitative requirements, the emphasis is more on the maximum amount of debris that can be left (i.e., as per utilization standards) versus how much needs to stay on the site.

Guidelines for snag and live tree retention, activities in riparian areas, and soil damage are more comprehensive than guidelines for retention of downed woody debris. However, for New Brunswick, specifications for retention of dead and live trees were not found. Having these detailed guidelines for retention of dead and live trees implies that attention is being paid to having future sources of CWD, which relates to sustainability of the biomass resource. Forestry activities that are prohibited in riparian areas are also laid out, sometimes in great detail, for all provinces. In spite of the apparent prescriptive nature of the guidelines for some jurisdictions, there is consistently a reminder that site-specific conditions and situations need to be considered when developing forestry prescriptions. Manuals and guidebooks offer many recommendations (some are legal requirements) on measures to minimize harvesting impacts on soils, including, in some cases, providing hazard ratings for rutting, compaction, and erosion. Most provinces have maximum allowances for soil disturbance and rutting, although these were not found for Nova Scotia. The definition of rutting varies from jurisdiction to jurisdiction. Compaction is not specifically defined, probably because it is more difficult to quantify. Some manuals (e.g., for Ontario) contain detailed recommendations for best skidding and logging practices.

The provinces and territories all have protected areas reserved from logging (especially ecological reserves, which protect unique and sensitive ecosystems) where biomass harvesting is not permitted (i.e., because use of mechanized equipment or vehicles and removal of any woody material is prohibited). In Provincial Parks, forestry activity is generally not allowed, although it seems that logging could take place in parks if the Ministers chose this. Other types of protected areas are found in different provinces

and territories; for example, Quebec has numerous designations. While not exactly considered protected areas, wildlife retention patches are protected from logging, at least for a designated period after logging. Removal of individual green trees and snags left for wildlife and future recruitment of CWD is also not allowed and the general requirement is that if they fall they are left in place.

All of the provinces and some of the territories have some sort of ecological classification system for their forests and this allows for ecosystem-based management, whereby management interpretations can be developed on an ecosystem basis, although site-specific conditions and situations must always be considered. The degree to which ecological classification is used in management varies among jurisdictions. For some regions (e.g., portions of British Columbia), management strategies for woody biomass have been incorporated into the system at a fine scale (e.g., site series). For example, full-tree logging is not recommended in certain ecosystem units (e.g., dry poor sites) due to soil productivity concerns. As well, other ecosystem-based guidelines and interpretations related to soils, wildlife, biodiversity, and water have been made for ecosystem units in some regions of British Columbia. For example, disturbance of the organic soil later is not recommended on some sites, and winter logging is suggested. These types of guidelines have relevance to woody biomass harvesting, but, as far as could be determined, guidelines specifically aimed at biomass harvesting do not yet exist in the guidebooks for any of the provinces and territories. See McAfee and Malouin (2008) for a discussion of ecological classification approaches across Canada.

Canadian provinces and territories have Climate Change Action Plans or related policy that includes greenhouse gas (GHG) emission reduction targets. In those plans, replacement of fossil fuels with "renewable" or "green" energy sources is identified as a strategy to help achieve the targets. In addition to the Climate Change Action Plans, other provincial or territorial strategies, plans, policies, and acts related to energy have been developed. Forest biomass is often mentioned as a new renewable energy source, along with agricultural biomass, solar, tidal, wind, and geothermal power. None of the plans or strategies place legal requirements on generation of a certain amount of energy from forestry biomass. However, several of the provinces (e.g., Ontario, Quebec, Nova Scotia, New Brunswick) have targets for a certain amount (or percentage) of energy generated in the province to come from renewable sources (not necessarily forest biomass) by a certain year. The main recent energy strategies for each jurisdiction are summarized briefly in this report, as they may be helping drive the movement towards forest biomass harvesting, although they are not policies that set legal requirements for forest biomass harvesting operations.

Government programs to get new energy projects going are common across Canada. Some are geared specifically towards forestry biomass (e.g., the Biomass Heating Assistance Program in Quebec) while others (e.g., Nova Scotia's 2009 Energy Strategy) are more general. These programs may have a bearing on development of the biomass industry and are related to biomass allocation, so they are described here, although information about the status or outcome of the programs was not usually easy to find.

The policy for allocation of biomass varies from direct rights to the residues if a company has logged the site (e.g., British Columbia, Alberta) to competitive bidding (e.g., Quebec, Manitoba), to requests for expressions of interest (e.g., British Columbia, Ontario, New Brunswick). There are always

requirements as to who may use biomass. For example, the applicant must have an existing forest processing facility licence in Ontario, and calls for expressions of interest specify that biomass utilization projects are limited to a certain size or to certain groups.

In researching this paper, an attempt was made to obtain accurate and up-to-date information but the rapidly growing nature of the bioenergy industry makes this difficult. Specific policies related to forest biomass harvesting are right in the midst of being developed for some provinces (e.g., Saskatchewan) so some of the information in this report may soon be outdated. As well, legislation and operational guidebooks are continuously being revised, amended, and replaced. However, it is hoped that this report will help bring together the most relevant policies and guidelines affecting forest biomass harvesting in Canada at the present time.

5 PROVINCIAL AND TERRITORIAL POLICY

Although most jurisdictions have no official forest biomass harvesting policy, they all have some sort of guidelines or requirements related to retention of downed woody debris and recognize its importance for site and ecosystem sustainability. They are all looking at options to allow the use of harvesting woody biomass for energy, with varying levels of optimism about the endeavour due to concerns about the environment, supply, costs, and required technology. Most of the provincial or territorial regulations and guidelines for forestry operations in Canada were written when woody biomass was not considered a harvestable product, and so specific requirements for biomass harvesting have been lacking in policy. At a provincial or territorial level, the overarching strategies and policies related to increased use of woody forest biomass have often been led by energy rather than forest ministries (Waito and Johnson 2010).

5.1 British Columbia

5.1.1 The forest biomass resource British Columbia has the largest forest industry in Canada with an annual harvest in 2009 of about 48 million m^3 and a harvest area of 122 620 hectares (Natural Resources Canada 2011b). It is estimated to have the greatest volume of roadside harvest residues in Canada (13.7 million BDT p.a.) (Bradley 2010). This is almost one-half of the Canadian total and double that of Quebec, the province with the second greatest amount. The potential exists for British Columbia to provide 50% of its current fossil fuel needs from existing and new biomass resources associated with forestry, agriculture, and municipal waste (Ralevic and Layell 2006). Forest residues from the existing sustainable forest industry are estimated to be enough to contribute to almost 21% of the province's fossil energy demand (12 Mt dry)/yr) (Bradley 2010). This figure was arrived at assuming that 30% of the forest harvest would be residue and 70% of that could be removed. Residue and dead trees from the mountain pine beetle outbreak are estimated to be able to contribute an extra 11 Mt(dry)/yr until 2026, which would be enough to provide 19% of the province's energy needs.

5.1.2 Land ownership Ninety-six percent of British Columbia's forest land is publicly owned (Natural Resources Canada 2011b) so in this report the discussion of policies and guidelines affecting forest biomass harvesting is

limited to those that apply to Crown lands. Activities on private woodlots are legislated under the Woodlot Practices and Planning Regulation of the *Forest and Range Practices Act*.

5.1.3 Status of forest biomass harvesting policy There is a lot of interest in forest biomass harvesting in British Columbia and the province is currently promoting the use of harvest waste and standing mountain pine beetle–killed trees (Bradley 2010). Forest biomass harvesting in the province is currently focussed on removal of logging residues from landings or the roadside rather than entering blocks to remove material or harvesting unmerchantable stands (B. Harris, pers. comm., May 11, 2012). At present, there is no specific forest biomass harvesting policy in place to regulate the operations. If forest companies have a cutting permit, they have rights to all woody biomass on their blocks and may remove and harvest any material they wish, within the requirements of retention of CWD under the *Forest and Range Practices Act*, which are minimal. No special licence or agreement for biomass harvesting is required for these primary harvesting companies. The *Forest Act* now includes provisions for two timber tenures that have the purpose of accessing road and landing waste that will not be utilized by the person who conducted the original harvesting. These two fibre recovery tenures are the Fibre Supply Licence to Cut (FSLTC); and the Fibre Forestry Licence to Cut (FFLTC).

5.1.4 Existing forest biomass harvesting Currently there are quite few companies in British Columbia using residues from harvesting operations to generate energy, and in some cases to make pellets (R. Schuetz, pers. comm., Apr. 23, 2012). The main ones are:

- Atlantic Power (formerly Capitol Power) – uses roadside residues for power generation for sale to BC Hydro;
- Canfor Pulp – uses roadside residues to produce electricity both for their own uses and to sell to BC Hydro;
- Howe Sound Pulp and Paper – uses roadside residues primarily for electricity for sale to BC Hydro;
- Conifex – will use roadside residues for sale to BC Hydro and for internal energy offsets (new agreement; will likely start in summer 2014).
- Tembec (Skookumchuck) – uses roadside residues for internal use and sale of electricity to BC Hydro (fairly large program);
- Tolko (Armstrong) – has a small program to use roadside residues if close to town for both heat and power;
- Cariboo Pulp and Domtar – had small programs in 2010 but are currently not using roadside residues; and
- Pacific Bioenergy and Pinnacle Pellets – use roadside residues to fire their driers and also for making pellets.

Kwadacha First Nation has received funding from the First Nations Clean Energy Business Fund to be used for business planning and project management for a bio-energy project being developed in their community, about 600 km north of Prince George (Province of British Columbia 2012b). BC Bioenergy Network is leading the project. The community, which is not connected to British Columbia's electricity grid or its natural gas pipeline, has been using diesel as a power supply but plans are to use the abundance of forest biomass from an old forest fire to help meet the community's energy

needs. In September 2011, the BC Bioenergy Network, seeking to generate more projects, issued an Expression of Interest for woody biomass combined heat and power suitable for remote communities (Interior Science Innovation Centre 2011).

5.1.5 Energy strategies, initiatives, and policies

B.C. Climate Change Action Plan (Province of British Columbia 2007a)

In 2007, as part of the Climate Change Action Plan the British Columbia government established targets for GHG reductions in the province and made them law through the *Greenhouse Gas Reduction Targets Act* (Province of British Columbia 2007b). This would encourage the development of new energy sources with lower emission levels than traditional energy sources, such as forest biomass.

B.C. Energy Plan (British Columbia Ministry Energy, Mines and Petroleum Resources 2007)

The Energy Plan (2007) promoted the use of new renewable energy sources and reflected the province's increasing interest in using forest biomass.

Bioenergy Strategy (British Columbia Ministry Energy, Mines and Petroleum Resources 2008)

The Bioenergy Strategy addresses the commitments laid out in the B.C. Energy Plan. Highlights included establishing $25 million in funding for a provincial Bioenergy Network (mentioned above) to support greater investment and innovation in British Columbia bioenergy projects and technologies. A two-part Bioenergy Call for Power was issued. A commitment was made for at least 10 community energy projects that convert local biomass, such as from mountain pine beetle–killed wood, into energy by 2020. In 2008 BC Hydro issued the first call for proposals for projects that would generate electricity from sawmill residues, logging debris, and mountain pine beetle–killed timber. Twenty proposals were submitted and four were approved in 2009. In May 2010 there was a second call for which 13 proposals from 10 proponents were submitted and in August 2011 four Electricity Purchase Agreements were awarded (BC Hydro 2012).

5.1.6 Natural resource legislation

Waste Assessment Policy and **Logging Residue and Waste Measurement Procedures Manual** (British Columbia Ministry of Forests, Mines and Lands 2011)

Licensees in British Columbia must pay a penalty for merchantable timber that is not removed during harvesting, so the maximum amount of CWD left on a site is influenced by the timber merchantability specifications. However, depending on markets, licensees may choose to leave more woody biomass, and market forces rather than utilization standards may be the main force dictating the maximum amount of woody debris that remains after logging (N. Densmore, pers. comm., Apr. 27, 2012). However, billable waste can be insignificant, while total slash load

could be considerable due to tops, branches, and small stems (Zielke and Bancroft 2007). The Waste Assessment Policy states that "Merchantable timber, whether standing or felled, that is not reserved from cutting and remains on site upon completion of primary logging of each cutblock or at the expiry of the agreement or cutting permit is waste. The ministry will issue waste assessments charging for this waste subject to exceptions set out in waste relief below." Waste is defined as "timber, except timber reserved from cutting, whether standing or felled, which meets or exceeds the timber merchantability specifications described for the Coast and Interior in the Provincial Residue and Waste Measurement Procedures Manual that was not removed from the cutting authority." Waste assessments are carried out under the authority of: (1) the *Forest Act;* (2) the Waste Assessment Policy; (3) the Provincial Residue and Waste Measurement Procedures Manual; and (4) Agreement and cutting permit documents.

Fibre Recovery Tenures (British Columbia Ministry of Forests, Lands and Natural Resource Operations, 2012)

In 2012, the Ministry of Forests, Lands and Natural Resource Operations announced new provisions in the Forest Act for two timber tenures intended for use in accessing road and landing waste not utilized by the person who conducted the original harvesting. These two fibre recovery tenures are the Fibre Supply Licence to Cut (FSLTC) and the Fibre Forestry Licence to Cut (FFLTC). Once harvesting is completed on a specific block, the primary harvester is required to provide notice whether or not the waste remaining on the block will be utilized. If not, the rights to the fibre may be allocated to the holder of one of these tenures. Along with these new tenures came amendments to regulations under the Forest and Range Practices Act (Forest Planning and Practices Regulation, see below) and the Wildfire Act.

Forest and Range Practices Act (FRPA) (Statutes of British Columbia 2004a)

FRPA is the major piece of legislation guiding forestry operations on Crown land in British Columbia, setting out requirements that must be adhered to including sustainable management of forest resources and the requirement of an approved Forest Stewardship Plan (FSP) before any harvesting is done. The FSPs must state intended results or strategies to achieve the objectives set by government in the act or its regulations and if not complied with, measures may be taken that could include monetary fines. Forest biomass harvesting is not specifically mentioned in FRPA.

Forest Planning and Practices Regulation (FPPR) (Statutes of British Columbia 2004b)

In their plans, tenure holders must state how they will address government objectives for timber, soils, water, fish, wildlife, biodiversity, visual quality, and cultural heritage resources. FPPR requires: (1) conserving productivity and hydrologic function of soil; (2) conserving sufficient wildlife habitat in terms of area, distribution of areas, and attributes of those areas for the survival of species at risk the survival of regionally important wildlife, and the winter survival of specified ungulate species; (3) conserving, at the landscape level, water quality, fish habitat, wildlife

habitat, and biodiversity associated with riparian areas; (4) designing areas on which harvesting is to be carried out that resemble, both spatially and temporally, the patterns of natural disturbance that occur within the landscape; and (5) retaining wildlife trees. All of these objectives must be met without "unduly reducing the supply of timber from British Columbia's forests." However, CWD management strategies are not included in an FSP (N. Densmore, pers. comm., Apr. 27, 2012).

FPPR sets a minimum amount of CWD that must be retained on logged sites. At least four logs per ha on a cutblock, each being a minimum of 5 m in length and 30 cm in diameter at one end for the Coast, and a minimum of 2 m in length and 7.5 cm in diameter at one end for the Interior must be retained. The regulation does not apply if an authorized controlled burn is carried out or the holders agreement or an enactment requires the holder to act contrary to this regulation. British Columbia is the only province that legislates the number of logs that must be retained following harvesting. Quebec specifies the percentage of slash that must be retained after logging; other provinces do not set minimum levels for retention. In British Columbia the amount of woody debris that must be left on a site is somewhere between the minimums in FPPR and the maximums set by the utilization standards.

A minimum 3.5% of a block area must be maintained as wildlife tree retention areas where harvesting is not permitted. A wildlife tree retention area can be used for more than one block. Forest activities must not "damage or render ineffective" wildlife features and resource habitat features. Although forest biomass harvesting is not specifically mentioned, presumably it is not allowed in these areas.

FPPR has specifications for allowable soil disturbance: a maximum of 5% of the area to be reforested may be affected by soil disturbance (gouges, ruts, scalps, and compaction) for sensitive soils, and a maximum of 10% of the area where soils are not predominantly sensitive. Sensitive soils are defined as those that, because of their slope gradient, texture class, moisture regime, or organic matter content, have a very high hazard for the Interior, or a high or very high hazard for the Coast, of displacement, surface erosion, or compaction. Allowable soil disturbance in roadside work areas is 25% of the area covered by a roadside work area.

In 2012, revision to the soil disturbance provisions (section 4.1) of FPPR added a section saying that "if a first agreement holder is authorized to carry out timber harvesting in an area and a fibre recovery tenure holder is authorized to carry out timber harvesting in an area that overlaps with the area of the first agreement holder, the agreement holders must not cause the cumulative amount of soil disturbance from all primary forest activities carried out on the area of overlap to exceed 25% of that area" (Province of British Columbia 2012a). Because the intent of the new fibre recovery tenures is to access road and landing waste not utilized by the person who conducted the original harvesting, it seems likely that the intent of this provision is to hold the permitted upper limit for soil disturbance in the roadside work area (where harvesting wastes are piled) to 25%.

Forestry activities must also not cause landslides, gully processes, or fan destabilization that have adverse effects in relation to soils, timber,

forage and associated plant communities, water, fish, wildlife, biodiversity, recreation resources, resource features, visual quality, or cultural heritage features. Presumably the allowable amount of soil disturbance is the total of that caused by the conventional logging combined with any additional forest biomass removal.

FPPR sets out requirements for riparian areas. Buffer widths for Riparian Management Areas (RMAs) vary from 20 to 100 m, depending on the class of the stream (larger buffers for bigger streams). Buffers for Riparian Reserve Zones (RRZs) vary from 0 to 50 m, and for Riparian Management Zones (RMZs) 20–100 m. Wetlands have different riparian classes depending on the wetland size and biogeoclimatic zone; buffer widths vary from 30 to 50 m for RMAs, 0–10 m for RRZs, and 20–40 m for RMZs. Similarly, lakes have varying riparian classes depending on size and biogeoclimatic zone: 0–30 m for RMAs, 0–10 m for RRZs, and 0–30 m for RMZs. A RMA consists of an RRZ and an RMZ.

Restrictions in a Riparian Management Area:

- No road construction unless locating the road outside the RMA would create a higher risk of sediment delivery to the adjacent stream, wetland, or lake, there is no other practicable option for locating the road, or the road is required as part of a stream crossing;
- Road maintenance is restricted to the road clearing except to maintain a stream crossing; and
- Gravel or other fill must not be removed unless it is within the road prism, or the gravel or fill is at the stream crossing, or there is no other practicable option.

The above restrictions would apply to forest biomass harvesting if roads were altered specifically for biomass harvesting (i.e., after the conventional logging was completed).

In a Riparian Reserve Zone, trees may not be cut, modified, or removed, except for:

- Felling or topping a tree that is a safety hazard;
- Topping or pruning a tree that is not windfirm;
- Constructing a stream crossing;
- Creating a corridor for full suspension yarding or creating guy line tiebacks;
- Carrying out a sanitation treatment;
- Felling or modifying a tree that has been windthrown or has been damaged by fire, insects, disease, or other causes, if the felling or modifying will not have a material adverse impact on the RRZ;
- Felling or modifying a tree under an occupant licence to cut, master licence to cut, or free use permit issued under the *Land Act, Coal Act, Geothermal Resources Act, Mines Act, Mineral Tenure Act, Mining Right of Way Act, Ministry of Lands, Parks and Housing Act,* or *Petroleum and Natural Gas Act,* if the felling or modification is authorized; and
- Felling or modifying a tree so that an interpretive forest site, recreation site, recreation facility, or recreation trail can be established or maintained.

These felled, topped, pruned, or modified trees may only be removed if they will not have an adverse effect on the RRZ. With the above exceptions, it seems clear that forest biomass harvesters must not remove trees in RRZs.

In Riparian Management Zones, trees may be felled if a basal area of at least 10–20% is retained beside streams (depending on stream size), and at least 10% is retained beside all classes of wetlands and lakes. The trees that are left standing must be "reasonably" representative of the physical structure of the riparian management zone before harvesting. For S4, S5, and S6 streams (the smaller sizes of streams), enough trees must be left to maintain streambank or channel stability if the streams are direct tributaries to S1, S2, or S3 streams, or if the stream flows into the ocean where there are specified shellfish or fish habitat features. The regulation does not specify any difference in the amount of down forest biomass to be left in an RMZ compared to the rest of the logged block.

The environment must not be damaged as a result of forestry activities unless the person is acting in accordance with the plan, authorization, or permit, or does not know, because of weather or site factors, that carrying out the practice will result in damage. Damage means a landslide, gully process, or fan destabilization on the Coast; soil disturbance; deposit into a stream, wetland, or lake of a petroleum product, fluid used to service industrial equipment, or other similar harmful substance; a debris torrent that enters a fish stream; or changes to soil. If the environment is damaged, action must be taken to prevent further damage. The District Manager must be promptly notified, and remedial measures required by the Ministry must be taken. The requirement of no damage would presumably apply equally to forest biomass harvesting and conventional logging.

5.1.7 Guides

Maintaining Soil Productivity in Forest Biomass Chipping Operations Best Management Practices for Soil Conservation (Kabzems et al. 2011)

This report summarizes research on effects of chipped woody material accumulations on site hydrology and productivity, interprets these findings, and provides guidance for best management practices to maintain long-term site productivity. Recommendations include:

- Soils in cooler climates, on fine-textured soils, and/or with a high water table are at a greater risk of detrimental effects than well-drained, coarse-textured soils in warmer environments;
- Integration of conventional and biomass harvesting can reduce repeated equipment traffic on forest sites;
- Care should be taken to ensure that biomass harvesting operations do not result in site organic matter levels that are below requirements in existing guidance documents, guidelines, and regulations;
- Placing chipped material directly into containers used to transport chips to the processing facility, or using heavy tarps to create temporary chip storage containers, can maximize biomass recovery and avoid creation of residual piles on future forest sites; and
- To facilitate tree regeneration and forage production, large accumulations of materials need to be removed or redistributed so that the

resulting soil mulch of woody material is discontinuous and preferably <8 cm in depth.

Chief Forester's Guidance on CWD (Province of British Columbia 2010)

In May 2010, the Chief Forester's Guidance on CWD Management was released. It is not a legal document but was written to raise awareness about the importance of CWD planning and management before and during logging, and to provide guidance to resource professionals on how to manage for it on Crown forest land in British Columbia. The Chief Forester indicates that CWD is being considered as a source of bioenergy products in British Columbia, and outlines the following guidelines for managers to consider, regardless of its end use:

- It is important to retain a full range of decay classes, diameter classes, and species on a site, variability in the amount of CWD at the site and landscape level, overlapping logs off the ground, and standing trees for recruitment in later stages of the rotation;
- It is appropriate to retain lower amounts of CWD where fire hazard is high and next to the wildland–urban interface;
- Retention of CWD must be balanced against silvicultural requirements, such as the need for plantable spots; and
- Large piles at roadsides and landings would be of greater value if dispersed in many smaller aggregations scattered across a block.

The median number of large (≥20 cm in diameter and ≥10 m in length) CWD pieces per hectare that are recommended to be retained in harvested areas for selected biogeoclimatic subzones and zones are listed in the guidelines. These data come from CWD monitoring done as part of the Forest and Range Evaluation Program (Densmore 2011). She states that a long-term goal for biodiversity would be to have, over many blocks in an ecosystem, similar densities of large CWD in harvested and unharvested areas. These data provide a guideline for the minimum amount of coarse woody forest biomass to be left after logging, but as with many other guidelines summarized below, fine woody debris is not addressed.

Best Management Practices for Soil Conservation in Mountain Pine Beetle Salvage Operations (Berch et al. 2009)

In December 2005, the Chief Forester released guidance on landscape- and stand-level structural retention in large-scale mountain pine beetle (MPB) salvage operations (Snetsinger 2005) but soil conservation within the cutblock was not addressed. Accordingly, this document provides guidance on harvest planning and operations in MPB salvage to conserve soil productivity, including these recommendations:

Scheduling and season of harvest

- Plan operations, including time of harvest, based on the sensitivities of all soils in the harvest unit regardless of the size of the standard unit against which excessive soil disturbance is measured. Even in areas of apparent uniform sensitivity, small wet drainages and draws should be recognized and avoided so that natural surface drainage patterns are not impeded. Consider soil moisture conditions at the time of harvest because soil water conditions within MPB areas

change continuously as trees die, road networks increase, and areas of salvage logging increase. Consider harvesting low-sensitivity soils in wetter periods and the most sensitive soils only once the soil dries or in winter under sufficient snowpack;

- Focus harvesting on winter months but do not extend past spring shutdown (snowmelt and beyond) when soils are saturated and easily disturbed. Soils in the Interior are generally unfrozen under a snowpack (warm wet snow, if deep enough, is the most protective of the soil), and, during periods of low snowpack, wet, unfrozen soils will be highly susceptible to soil disturbance;
- Avoid spring and wet summer or fall harvesting, especially on toe-slope positions and in wetter (subhygric to hygric) sites or portions of a harvesting unit. This includes sites where soils have restricting layers that can impede drainage. When salvage logging must be hurried under these conditions, pre-harvest activities such as forest drainage could be carried out to reduce soil moisture. Drainage is not a panacea, and the potentially negative long-term impacts of altering natural drainage of a site must be weighed against the possible short-term benefits of improved operability. In drier areas of the province, including the Southern Interior, wet soils may not be a concern under normal summer and fall precipitation, except on the most sensitive sites;
- Early identification of green-attack stands, especially those without advanced regeneration, reduces the risk of on-site moisture problems because harvesting can be carried out before the stand dies; and
- When harvesting red- and grey-attack trees, take the time to let the soils properly dry before beginning ground-based harvesting because soils take longer to drain excess moisture under dead stands.

Choice of equipment

- If harvesting under unfavourable soil moisture conditions is unavoidable, consider using innovative or non-conventional harvesting strategies (e.g., hoe chucking, designated trails, or low ground pressure equipment).

On-the-ground strategies

- When harvesting during the snow-free season, weather-related shut-down may need to occur more rapidly than normal because of higher soil moisture contents;
- Retain areas with live trees as a first priority in order to maximize the potential to remove water from the soil through evapotranspiration;
- Retain advanced regeneration and understorey vegetation during salvage operations whenever practicable to maximize the potential to remove water from the soil through evapotranspiration;
- During the growing season, do not cut trees too far in advance of skidding and bucking. This ensures that any live trees continue to transpire and reduce soil moisture levels until immediately before skidding, the most risky ground-based operation;
- Construct, inspect, and maintain roads to ensure that natural surface and shallow subsurface drainage remain intact both during and after salvage; and

- Upgrade drainage networks on permanent roads before salvage logging as necessary to accommodate expected increases in peak flows.

Rehabilitation options

- Plan for rehabilitation of main trails, roadside work areas, etc. if high soil moisture contents during harvesting are expected. Causing soil disturbance that must be rehabilitated is a less desired approach than delaying harvest until the soil dries. When a disturbed area requires rehabilitation, soil moisture conditions at the time of rehabilitation will be an important consideration for success. Soils that respond well to treatment in dry conditions may be further damaged if treated when too wet.

A Short-term Strategy for CWD Management in British Columbia's Forests (Province of British Columbia 2000)

This strategy was developed as a result of extensive consultation with the forest industry, Ministry of Forests, and Ministry of Environment, Lands and Parks. It preceded the Chief Forester's guidance (May 2010) summarized above. The strategy was intended to be used with flexibility and professional discretion to balance ecological and fiscal considerations. The focus here is on preservation of a certain amount of woody debris on logged sites. Guidance for CWD management is:

- Minimize CWD accumulations, especially on landings and roadsides, bearing in mind that some accumulations will be inevitable for reasons of safety and operations. Some small CWD piles dispersed in cutblocks may be appropriate to provide valuable habitat for some mammals;
- Larger pieces of CWD are more valuable than smaller pieces—they last longer, hold more moisture, and are useable structures for a greater number of organisms;
- Ecologically, it is advantageous to maintain the full range of decay and diameter classes of CWD on every site—different functions and ecosystem processes require CWD in different stages of decay;
- Coniferous material lasts many times longer than deciduous material and therefore remains part of the useable structure of a stand for a much longer period of time. However, the faster decay rate of deciduous CWD likely provides significant short-term ecological benefits. Retention of a diversity of species is advantageous;
- CWD can be managed in conjunction with wildlife trees and other constrained or reserve areas. Standing live and dead trees and/or stubs retained on cutblocks are important sources of CWD recruitment;
- CWD has extra value in riparian areas, which are valuable habitat for many wildlife species. CWD entering or falling across a stream produces habitat for fish, invertebrates, and vegetation. Most importantly, it contributes to stream geomorphology. Excessive amounts of fine woody debris can have negative effects on stream biology;
- Manage the composition and arrangement of CWD within acceptable levels of risk of wildfire, and insect pest and forest disease outbreaks. For example, the risk of bark beetle activity should be evaluated

where wildlife trees blow down or if many large trees are felled and left in place;

- Harmonize the retention of CWD with all other silvicultural objectives. During site preparation minimize piling and windrowing. If piling, minimize pile sizes. Mix piles with scattered debris and avoid placing large pieces in piles unless they are required for specific wildlife species. Minimize burning of piles and accumulations, but do not create undue fire or forest health hazards. Use techniques other than broadcast burning to reduce fire hazard and create plantable spots. If broadcast burning, burn under conditions that remove fine fuels but maintain CWD and the organic soil layer. Wherever possible, maintain CWD in place and do not disturb or break it up with heavy equipment. In special circumstances it may be necessary to modify stocking standards to meet CWD objectives due to debris accumulation and reduction of plantable spots. Options include modifying target stocking levels, modifying the minimum allowable distance between trees, and utilizing clumped planting patterns. Stand tending should be planned to allow for future recruitment of CWD;
- Maintain variability in the levels of CWD at the landscape level. The natural distribution and amounts of CWD will vary according to biogeoclimatic gradients, stand types, and stand development history. Although the natural distributions of CWD cannot be mimicked exactly, it is important that CWD management captures landscape variation and site-specific variations through different management practices;
- If "uneconomic wood" resulting from harvesting (e.g., breakages, short pieces, tops, and low-grade timber) is intended to be left behind as CWD, harvesting should be planned to minimize damage to these pieces; and
- When stands affected by catastrophic disturbances are salvaged, efforts should be made to ensure a good distribution of CWD over the area. Retaining incidental windthrow in sensitive ecosystems such as riparian areas and Wildlife Tree Patches will ensure long-term CWD recruitment within these areas.

Retention Measures to Address Ecological Values in Mountain Pine Beetle Affected Forests in B.C. (Martin 2006)

This report is a compilation of existing literature from across British Columbia related to the MPB epidemic, and recommends retention practices that will help maintain biodiversity values during salvage logging in Interior British Columbia. The general management approach is to mimic nature. Under natural conditions, most beetle-killed stands would have high levels of CWD, so Martin concludes it is intuitive to leave an abundance of dead standing or downed wood in stands heavily affected by MPB. FRPA retention guidelines (four logs per ha) are minimums and meeting only those minimums would not be sufficient for natural mimicry of beetle-killed salvage areas. The recommendations for CWD retention during stand-level salvage are:

- Retain any CWD greater than 15 cm in diameter where it lies;

- Levels of merchantable wood that are retained should be close to the waste benchmarks, which vary by site: 4 m^3 on dry sites, 10 m^3 on mesic sites, and 20 m^3 on wet sites;
- Retain CWD on a site in a way that mimics its natural distribution of randomness and connectivity, with some clumping and layering;
- Where present, maintain and/or recruit a mixture of both coniferous and deciduous CWD. Coniferous CWD decays slower than deciduous CWD, providing ecological benefits for a greater period of time. Deciduous CWD provides important short-term ecological benefits;
- Where safe to do so, retain some standing live trees and snags, and/or mechanically harvested stub trees, to provide sources of recruitment CWD. Retain larger-diameter sizes where present (recommend >50 cm dbh);
- Retain and recruit a range of naturally occurring CWD ground cover on cutblocks, well-distributed across the forest floor on site. Depending on the site (i.e., forest floor and stand age), the amount will vary widely;
- Retain and/or recruit some larger CWD pieces (>5 m long and >40 cm in diameter). Larger material decays more slowly, holds more moisture, presents less of a fire hazard, and provides more habitat value to a greater number of wildlife species for a longer time;
- Maintain some CWD in loosely layered, low-height (<1 m) piles of up to 3 m in width. Some longer pieces (>5 m) of CWD should radiate from the pile to provide linear travel corridors for small mammals;
- Where mechanically harvested stub trees are left in cutblocks, consider arranging loosely stacked CWD piles around stubs, using the stub as the central axis of the pile. Stub trees should be cut as high as possible (at least 5 m);
- Where practical, process the timber on site rather than at the landing to minimize CWD accumulations at roadsides and landings;
- Retain any log grades that have been identified in higher-level plans or operational plans to fulfill CWD objectives on an area-specific basis. For example, the following log grades should be retained as CWD: (1) Grade 6 undersized logs and firmwood reject logs that have >50% of the gross log scale as sound wood. (2) Grade 5 dead and dry lumber reject logs that are rejected as lumber grade and were dead and dry when harvested; and
- CWD piles can be located almost anywhere on the block, but it is most efficient to situate them around existing structural elements or machine-free zones with special attention to retention of clumps in Riparian Reserve Zones.

Forest Stewardship in the Context of Large-scale Operations: An Interpretation Paper (Eng 2004)

This document was prepared at the request of the Chief Forester during an expedited Allowable Annual Cut determination process for the Lakes, Prince George, and Quesnel Timber Supply Areas. Recommendations for CWD management in mountain pine beetle salvage operations are:

- Legacies of CWD should be left throughout the blocks;
- FRPA default values may be suitable for harvesting "healthy" forests

but are far too low for salvage operations. Under natural conditions CWD levels would be high; and

- The targets for CWD retention should be closer to the recommended waste billing benchmarks, which are: 9 m^3 on dry sites, 15 m^3 on mesic sites, and 25 m^3 on wet sites.

These recommendations indicate that biomass harvesting in MPB affected stands should not remove as much woody debris as in unattacked areas.

Strategies for Maintaining or Recruiting Habitat in Areas Affected by Mountain Pine Beetle and Other Catastrophic Events (Manning et al. 2006) and **Silviculture Guidelines and Practices for Maintaining or Recruiting Key Habitat Objectives** (Manning, Cooper and Associates 2004)

These two reports contain detailed guidelines for CWD management specifically considering its value as wildlife habitat. Recommendations are the same in the two reports. The reports indicate that development of specific regimes to achieve CWD objectives will not be possible at a broad scale, and must first be considered at the landscape level, and that stand level practices that achieve the desired CWD objectives through rotation are extremely varied. Some recommendations are similar to those of the Chief Forester and recommended management guidelines for silviculture activities are the same as in the Short Term Strategy for CWD Management in British Columbia's Forests. Recommended general measures are:

- Retain CWD on a site in a way that mimics natural distribution and connectivity, with some clumping and layering;
- Where present, maintain and/or recruit a mixture of coniferous and deciduous CWD; and
- Where safe, maintain some standing live trees and snags or stub trees on site to provide sources of recruitment CWD. Retain larger-diameter trees where present (>70 cm dbh for Coastal regions and >50 cm dbh for Interior regions).

Management guidelines are:

- Retain and/or recruit a range of naturally occurring well distributed CWD ground cover on cutblocks; will vary widely, depending on stand age;
- Retain and/or recruit a range of CWD piece sizes (diameter and length) and decay classes (intact and hard to partially decayed; log classes 1–3 preferred. These are the lesser decomposed classes);
- Retain and/or recruit some larger CWD pieces, >5 m long and >40 cm diameter;
- Maintain some CWD in loosely layered, low-height (<1 m) piles of up to 3 m in width. Some longer pieces (>5 m) should radiate from the pile to provide linear travel corridors for small mammals;
- Where mechanically harvested stub trees are left in cutblocks, arrange loosely stacked CWD piles around the stubs, using the stub as the central axis of the pile. Such stub trees should be at least 5 m in height if possible;

- Where practical, buck, limb, and top trees on site rather than on landing, which will minimize CWD accumulations at roadsides and landings; and
- Catastrophic windthrow should generally be harvested if possible, but some left on site due to breakage, riparian management restrictions, or economic inaccessibility will serve as future CWD. Non-catastrophic blowdown should be left unsalvaged and will serve as a source of continuous CWD input over the rotation of a stand.

Retention Strategies to Maintain Habitat Structure and Wildlife Diversity during the Salvage Harvesting of Mountain Pine Beetle Attack Areas in the Southern Interior Forest Region (Klenner 2006)

This report outlines some stand-level practices to help protect and maintain habitat structure and wildlife diversity during large-scale salvage harvesting. The message conveyed here is that forest biomass harvesting would not be desirable in these types of situations, at least in terms of wildlife habitat. Recommendations specific to woody debris are:

- Retain as much downed wood, well-dispersed across the site, as possible;
- Retain non-merchantable snags and green trees, especially large-diameter material, either standing or cut and left at the stump, rather than hauling to cull piles. Complement this with non-merchantable piece sizes and low-quality material (e.g., pulp grades) wherever feasible; and
- Scattered small piles of downed wood (e.g., 10–20 m^3) complement dispersed downed wood by providing subnivean (the relatively open, crystalline layer that forms between the ground surface and snowpack) access points for species such as marten.

Mountain Pine Beetle Infestations: CWD and Impacts on Furbearers (Manning and Chytyk 2008)

Habitat management recommendations related to CWD for furbearers following mountain pine beetle attack in British Columbia are summarized in this document and are similar to those above:

- Retain tree species other than lodgepole pine when harvesting. Avoid salvage in areas where pine represents < 40% of the species mix. Where safe to do so, retain non-merchantable snags and non-merchantable green trees, especially large-diameter material, either as standing trees or as cut-and-leave at the stump (rather than hauling to cull piles);
- Retain and/or recruit a range of naturally occurring CWD (varying size, tree species, and decay class). Retain and/or recruit some larger CWD pieces (> 5 m long and > 40 cm diameter). Wherever possible, maintain pre-existing CWD in place—do not disturb it with heavy equipment. Winter harvesting will usually minimize impacts to forest floor material;
- Retain CWD on site in a way that mimics its natural distribution, with some patchy clumping and layering;
- Maintain some CWD in loosely-layered, low-height (< 1 m) piles of up to 3 m in width. Arrange some longer pieces (> 5 m long) of CWD to radiate from the pile to provide linear travel corridors for small mammals; and

- Where stubbing is done, cut trees as high as the feller-buncher can safely reach (usually >5 m). Select some of these stubs (especially those near the middle of harvest openings) to be anchors for CWD piling. CWD can be loosely piled around the stubs to provide additional summer and winter habitat for small mammals.

Mountain Pine Beetle Management Strategy – Okanagan-Shuswap Forest District (Province of British Columbia 2005)

Recommended stand-level management strategies for woody debris in average conditions in MPB-attacked stands in the Okanagan-Shuswap District are provided. The point relating to the relationship between amounts of CWD retained (not just future recruitment) and clearcut size is not found in other guidelines.

- The amount of stand-level retention, including CWD, merchantable, and non-merchantable timber, should be increased as the size of clearcut openings and the distance to landscape-level retention areas increases;
- Provide vertical structure, spatial heterogeneity of habitats, and dispersed CWD over the long term (i.e., for the duration of the harvest rotation period); and
- Enhanced CWD retention dispersed over the cutblock will not be subject to waste charges if identified for retention in the cutting permit.

Recommended Operational Procedures to address Hydrologic Concerns (Province of British Columbia 2004)

In this paper, practices are recommended to address the hydrologic issues associated with expedited harvest of MPB-attacked areas. Guidelines for retention of woody debris for hydrology purposes are not as common as other types of recommendations (e.g., for wildlife), and the recommendations in this paper are brief:

- Leave logging slash on site. The slash will slow snowmelt, reduce wind speeds (and thus sublimation), maintain soil moisture, and aid in site regeneration; and
- If a riparian area has more live wood than dead wood, it is better to leave the dead wood than to disturb the whole site by removing it.

Indicator Targets and Management Recommendations for CWD (Wildlife Infometrics 2008)

Retention of CWD during logging operations in the Mackenzie Defined Forest Area is based on default values from current regulations, but the local Public Advisory Group considered those requirements to lack sensitivity to variation in ecosystems. They considered baseline targets set by legislation and those established in other sustainable forest management (SFM) plans, and summarized data from natural forest ecosystems to come up with recommended targets to guide licensees on the amount of CWD to be retained. This varied from 60 m^3/ha to 140 m^3/ha for sites in variants of the BWBS, ESSF, and SBS zones. This is much higher than recommendations from other sources.

Silviculture Prescription Data Collection Field Handbook (Curran et al. 2000)

Forest Practices Code Silviculture Prescriptions (SPs) were required to state the volume and size range of pieces of CWD that existed before logging to accommodate any objectives for CWD established in a forest management plan. The guidelines recommended leaving CWD in the stand within utilization standards, with larger-sized pieces preferable. CWD should be as well distributed as possible throughout the block. In drier ecosystems much of the forest floor is derived from CWD so it needs to be maintained on site. The guidelines also list procedures for maintaining wildlife trees and providing future wildlife trees. SPs are no longer required so these guidelines are not current.

Forest Practices Code Guidebooks (Province of British Columbia 1995a,b; 1999a,b; 2001)

The Soil Conservation Guidebook (2001), Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook (1999), Mapping and Assessing Terrain Stability Guidebook (1999), Biodiversity Guidebook (1995), and Riparian Management Area Guidebook (1995) were part of the *Forest Practices Code of British Columbia Act*, which was replaced by the *Forest and Range Practice Act* in 2004. They are not part of current regulations, but still could be used for guidance. The recommendations in the guidebooks were never mandatory requirements; however, once a recommended practice was included in a plan, prescription, or contract, it became legally enforceable. The guidebooks tend to be quite prescriptive.

The Soil Conservation Guidebook provides recommended allowable soil disturbance (including compaction, ruts, trails, gouges, and scalps) in the net area to be reforested (5% for Coastal sites and 5–10% for Interior sites, depending on the leading soil disturbance hazard rating). Higher levels of soil disturbance were allowed in some circumstances. Procedures for determining hazard ratings are in the Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook. Hazard ratings included the soil compaction and puddling hazard, soil displacement hazard, soil erosion hazard, and risk of sediment delivery to streams, and depended on site and soil factors. The Hazard Assessment Guidebook includes recommended types of machines and operating conditions/seasons, as well as soil considerations for operations at the roadside, including processing and loading.

The Riparian Management Area Guidebook recommends that trees felled in the reserve zone should be left as CWD and windthrown trees should not be removed from riparian management areas as they provide valuable wildlife habitat. Windthrown trees should be removed only if habitat would be improved by their removal and removal would not result in damage to the surviving trees.

The Biodiversity Guidebook states that maintaining CWD after harvesting is a critical element of managing for biodiversity, but recognizes that this requirement conflicts with utilization standards. Work was described as being under way to resolve this policy conflict, and until then, utilization standards were to take precedence over requirements for CWD. The guidebook indicates that despite this policy conflict some existing practices can be modified to help address the requirements for

CWD. For example, post-logging residue and waste can meet the volume requirements for CWD if it is well distributed across the entire stand. This will not be the case in situations of whole-tree harvesting, clean site preparation practices, or excessive salvage of material not considered merchantable under current utilization standards. Recommendations were to: modify whole-tree harvesting by limbing and topping on site; maintain residue and waste well-distributed across the stand (avoiding practices such as piling and burning), and leave non-merchantable material on site.

Field guides for ecosystem identification and interpretation

Ecosystem classification guidebooks have been developed for each forest region in British Columbia, although most are in the process of being revised. They include varying references to CWD management (but not forest biomass harvesting specifically), and for some regions interpretations are provided at the site series level. Relevant guidelines are summarized below:

Vancouver Forest Region (Green and Klinka 1994)

- "Larger pieces [of CWD] are preferable and should be retained in the stand when utilization standards are being applied and site preparation treatments are planned," "second-growth stands may require special management to ensure some CWD remains after harvest," and "CWD is typically abundant in the CWH after harvest of old growth";
- Retention of wildlife trees should not compromise worker safety. Retain green trees during harvesting as a source of large-diameter snags in future rotations. Wildlife trees should be as large as possible; retain >3 stems/ha in the upper 10% of the diameter range of the stand. Maintain snags in a range of decay classes. The number of wildlife trees to be retained is not suggested, but is recognized to depend on the ecosystem, topography, adjacent stands, and overall landscape conditions; and
- Site sensitivity ratings are provided for ground-based harvesting based on slope, terrain, and compaction ratings, and several recommendations are made to help minimize soil degradation, such as restricting ground skidding to drier conditions, minimizing the number of passes, avoiding scalping or excavating, and orienting skid trails along the contour.

Cariboo Forest Region (Steen and Coupe 1997)

- Management interpretations for some site series (generally wetter) include that traffic should be restricted to frozen or dry soil conditions on fine-textured soils because they are vulnerable to compaction under wet conditions; and
- Site series that are zonal or drier in many variants of the IDF, MS, SBPS, and SBS biogeoclimatic zones and drier than zonal in many variants of the ICH and ESSF need retention of soil organic layers and woody debris to maintain site productivity.

North Central portion of Northern Interior Region; Southeast, Southwest, and Northern Rockies portions of the Prince George Forest Region (Delong et al. 1993a, 1994; Delong 2003, 2004)

- Management interpretations for some site series include: "full tree harvesting will lead to nutrient depletion and seriously reduce cones; woody debris and cones should be distributed across these sites" and "sites with fine textured soils are vulnerable to compaction under wet conditions; restrict traffic to winter operations or dry soil conditions";
- General section on Reducing Slash during Harvesting states: "On ecologically sensitive sites many site preparation techniques used to reduce slash may also damage the site"; and
- Table showing wildlife species having CWD as important habitat.

Prince Rupert Forest Region (Banner et al. 1993)

- Management interpretations for CWD/slash not made at site series level;
- General recommendation that mechanical site preparation treatments that remove CWD or aggregate slash excessively should be avoided, since they reduce the habitat available to CWD users. Site preparation treatments that pile slash create clusters of prime habitat for potential "pest" species such as voles;
- General recommendation that CWD is most effective as wildlife habitat when it is well dispersed over the cutblock or grouped in small units; large piles of logs provide minimal habitat. Unmerchantable trees should be left where they fall; and
- Table of preliminary minimum structural objectives to be present at second-growth maturation on zonal sites recommends CWD (>10 cm diameter): SBSmc, ESSF, ICH, CWH, MH: 50 m^3/ha; SBSdk/SBPS: 25 m^3/ha. Minimum objectives for snags and trees of various sizes are also tabulated. Snags and CWD should represent a range of decay classes from hard to soft.

Northeast and Rocky Mountain Trench portions of the Prince George Forest Region (Delong et al. 1993b; Meidinger et al. 1998)

- No management interpretations.

Kamloops Forest Region (Lloyd et al. 1990)

- No management interpretations at present but are being considered for the upcoming revised version of the guidebook (pers. comm., M. Ryan, Apr. 23, 2012).

Nelson Forest Region (Braumandl et al. 1992)

- No management interpretations.

Wildlife Tree Retention: Management Guidance (Province of British Columbia 2006)

This document is a revision to wildlife tree management guidelines previously released in The Protection of Wildlife Trees (1985), Provincial Wildlife Tree Policy and Management Recommendations (2000), and Evaluation of Wildlife Tree Retention for Cutblocks Harvested between 1996–2001 under the Forest Practices Code (2002). The guidelines are made within the context of Provincial legislation and consider ecological, economic, and logistic factors. Attributes of high-value wildlife trees, wildlife tree patches, and dispersed wildlife trees are listed with the

footnote that no single retention strategy is appropriate for all sites, and factors such as stand type and condition, tree species, and windthrow hazard create unique conditions for each stand. Stand-specific considerations when deciding to salvage downed wildlife trees (e.g., forest biomass harvesting) are (1) worker safety, (2) the significance of forest health risks and/or fire hazards to the surrounding area, (3) the ability of the remaining standing trees to provide suitable wildlife tree habitat, (4) the contribution of fallen trees to site productivity and long-term habitat, (5) the availability of wildlife trees and CWD in adjacent harvested areas, and (6) the economic viability of the salvage operation and the potential timber supply impacts related to replacing the salvaged retention area.

5.1.8 Protected areas legislation This legislation identifies areas where woody biomass harvesting is not allowed.

Ecological Reserves Act (Statutes of British Columbia 1996a)

Ecological Reserves are areas of Crown land set aside as:

- Areas for scientific research and educational purposes associated with studies of productivity and other aspects of the natural environment;
- Representative examples of natural ecosystems in British Columbia;
- Examples of ecosystems that have been modified by humans where the recovery of the natural ecosystem can be studied;
- Areas with rare or endangered native plants and animals in their natural habitat; and
- Unique and rare examples of botanical, zoological, or geological phenomena.

These are the most protected areas in British Columbia; forest harvesting of any type is prohibited.

Parks Act (Statutes of British Columbia 1996b)

Under Section 5(3.1) in the *Parks Act*, conservancies are set aside:

a. for the protection and maintenance of their biological diversity and natural environments;
b. for the preservation and maintenance of social, ceremonial, and cultural uses of First Nations;
c. for protection and maintenance of their recreational values; and
d. to ensure that development or use of their natural resources occurs in a sustainable manner consistent with the purposes of paragraphs (a), (b), and (c).

The *Parks Act* states that "A natural resource in a conservancy must not be granted, sold, removed, destroyed, disturbed, damaged or exploited unless, in the opinion of the minister, the development, improvement and use of the conservancy in accordance with section 5 (3.1) will not be hindered by it." Commercial logging is prohibited in a conservancy without a park use permit.

For Class A, B, and C provincial parks: "A natural resource other than fish and wildlife taken, hunted or killed in accordance with the *Wildlife Act* and fish, game or wildlife stalked or pursued for observation or for photographic or study purposes . . . must not be granted, sold, re-

moved, destroyed, damaged, disturbed or exploited except as authorized by a valid and subsisting park use permit." A park use permit will not be issued unless, in the opinion of the minister, it is necessary for the preservation or maintenance of the recreational values of the park involved.

Recreation areas are defined as Crown land reserved or set aside for public recreational use. They differ from parks in that the Minister has greater discretion in issuing use permits.

5.2 Alberta

5.2.1 The forest biomass resource Alberta ranks fourth in Canada for volume and area of forest harvested in 2009 (19.8 million m^3; 71,249 hectares) (Natural Resources Canada 2011b). Bradley (2010) estimates that Alberta has about one-quarter of the amount of roadside residues in British Columbia. Readers are referred to Macdonald (2007) for more information on the amount of woody forest biomass available from harvest residues and non-merchantable forests in Alberta. The technical potential of producing electricity from forest or agricultural biomass through direct combustion is large in Alberta, but the logistics of collection and transport and the need to establish biomass combustion facilities can hinder this potential (Haugen-Kozra and Mihajlovich 2010). They note that Alberta does not anticipate MPB mortality reaching the levels found in British Columbia's forests, so making projections of bioenergy available from MPB salvage is premature.

5.2.2 Land ownership Eighty-nine percent of Alberta's forest land is provincial Crown land, 8% is federal, and 3% private (Natural Resources Canada 2011b). The information in this section applies to provincial Crown land only.

5.2.3 Status of forest biomass policy Alberta has not developed forest biomass harvest regulations (D. Patterson, pers. comm., May 11, 2012). Legal reviews have indicated that when timber is sold under a timber disposition the harvest residues are the property of the timber disposition holder who harvested the timber (as in British Columbia). If the timber disposition holder uses the harvest debris then they are required to meet the existing requirements for cleanup and reforestation as required for the timber disposition. Renewals of Alberta's Forest Management Agreements have been adding a clause that stipulates "the harvest residues become the property of the Crown if the timber disposition holder does not utilize them after two years of harvesting the timber."

5.2.4 Existing forest biomass harvesting The Government of Alberta is "interested in underutilized forest biomass being used to its fullest extent," and states that business arrangements for these volumes are the responsibility of the tenure holder and interested third parties (Province of Alberta 2010). The potential sources of this biomass are identified as roadside residue (e.g., low-quality trees or parts of the tree not collected during traditional harvesting), chipping of undersized trees and tops (whole tree utilization) not included in the AAC within merchantable stands, trees killed by insects, disease, or fire, non-merchantable salvage, woody waste located at mill sites and log sort yards, hog fuel, pulp mill black liquor and separated lignin, and existing peat harvesting licences. The following is a summary of information relating to the existing forest biomass harvesting industry in Alberta provided by Dave Patterson (pers. comm., May 11, 2012). Forest biomass

access is developing through partnerships between the bioindustry and the forest product companies. Mill residues are being used at the Drayton Valley Power, Grande Prairie Ecocenter, and Whitecourt Power combustion plants to produce electricity. The only harvest residues being utilized at this time are at the Dapp gasification plant producing 17 MWe electricity. Eighteen thermochemical conversion technologies are attempting to establish partnerships with forest companies to utilize forest harvest residues as a feedstock. Haul costs of harvest residues are unaffordable for production of electricity from combustion and steam; they are only viable using local hog fuel/mill residues for a maximum of $10/tonne. Gasification to produce electricity can afford the $35/tonne for harvest residues within 150 km. Only second-generation gasification (using gas turbines or reciprocating engines) and biorefineries can afford to pay $70/tonne to access the more remote harvest residues.

5.2.5 Energy strategies, initiatives, and policies In Alberta, the energy sector directly and indirectly is the single largest contributor to provincial Gross Domestic Product, income, employment, and government revenues (Province of Alberta 2008a). The Alberta energy sector has historically been focussed on non-renewable energy sources such as natural gas and oil, but in recent years government strategies acknowledge a need to develop renewable energy sources. Renewable energy is a theme throughout Alberta's recent energy policy, and woody forest biomass harvesting is referred to in several strategic plans. Wenig (2011) discusses energy policy in Alberta and reflects on and questions how fast and to what degree these renewable energy sectors are expected to progress. Some of the main energy policies related to renewable energy resources in Alberta are briefly described here.

Integrated Energy Vision (Alberta Energy 2006)

Here a vision is set out for future development of Alberta's energy resources, which would involve building on the strengths of its conventional resources and integrating renewable water, wind, solar, and biomass energy resources into the future picture. The vision includes the "innovative challenge" of using forestry biomass as an energy source with minimal environmental impact.

Nine Point Bioenergy Plan (Province of Alberta 2006)

The focus of this plan was to stimulate bioenergy development in Alberta. New initiatives under the plan included the availability of grants through three programs: the Bioenergy Producer Credit Program, the Biorefining Commercialization and Market Development Program, and the Bioenergy Infrastructure Development Program.

Getting Value from Every Fibre (Forintek Canada Corp. and Alberta Research Council 2007)

This is a statement of strategic opportunities for building Alberta's bioeconomy, which again includes a vision to use forest biomass for energy production. The bioeconomy is seen as a key area in Alberta's future.

Climate Change Strategy (Province of Alberta 2008a)

The Climate Change Strategy had three main goals: (1) to reduce GHG emissions by transforming how energy is used, applying energy-efficient

solutions, and conserving energy; (2) to store quantities of CO_2 in Alberta's geological formations rather than release it into the atmosphere; and (3) to transform the way energy is produced and to introduce cleaner, more sustainable approaches to energy production including wind, solar, hydrogen, and geothermal. Forest biomass was not specifically mentioned. GHG emission reduction targets were set for 2020 and 2050.

Provincial Energy Strategy (Province of Alberta 2008c)

This is a long-term action plan for Alberta to (1) reduce its carbon footprint through clean energy production and wise energy use, and (2) to sustain economic prosperity by diversifying its energy portfolio, creating value-added opportunities, and creating economic self-sufficiency. Pursuing alternative and renewable energy sources is part of the plan.

Renewable Fuels Standard

This is part of the Provincial Energy Strategy. The provincial government introduced a requirement to blend an average of 2% renewable diesel in diesel fuel and 5% renewable alcohol in gasoline sold in Alberta. Renewable fuels used to meet the standard were required to demonstrate at least 25% fewer GHG emissions than the equivalent petroleum fuel.

5.2.6 Policies and strategies related to sustainability

Land-use Framework (Province of Alberta 2008b)

Alberta's Land-use Framework is a plan for managing public and private land and natural resources to make sure that land use decisions consider future generations and balance environmental, economic, and social goals. Forest biomass harvesting would have to fit into the plan. The framework includes the Government of Alberta's intent to manage public lands for a variety of purposes and values. An important aspect of this is to conserve sensitive lands and natural resources (e.g., sensitive habitats, watersheds, historical resources, heritage rangelands).

5.2.7 Natural resource legislation

Forests Act (Statutes of Alberta 2000)

Alberta Sustainable Resource Development (ASRD), part of the provincial government, has the role of managing public natural resources through a variety of legislation, regulations, and policies including the *Forests Act*. The act requires Forest Management Plans for forestry operations, which must embrace the concept of sustainable forest management and recognize other resource users and values.

Forest and Prairie Protection Act

The Forest and Prairie Protection Regulations Part II (Statutes of Alberta 1972) includes responsibilities for debris disposal to reduce fire hazard. A holder of a timber disposition who creates a slash fire hazard because of their operations is responsible for reduction of the hazard to a safe level as determined by a forest superintendent, and hazard reduction must be done no later than 24 months after logging. For clearcut harvesting operations, slash hazard must be reduced by scarification with heavy

equipment, skidding of tree lengths with limbs attached to roadsides or landings with subsequent limbing and burning of all debris, prescribed burning of slash windrows, piles, or areas, crushing to an acceptable standard by heavy machinery, or other approved methods. This differs from woody debris management strategies previously described for British Columbia where crushing is not recommended. Where partial cutting is done, all limbs must be removed from felled trees and the unused parts of the tree including the limbs must be scattered and made to lie flat on the ground.

Forest Management Plans

Detailed Forest Management Plans (DFMPs) outline the goals, objectives, and strategies that operating companies on a Forest Management Agreement area will use to manage the forest resource. In these plans, goals for woody debris removal and retention are set out more specifically than in the legislation. For example, the Canfor Grande Prairie Operations DFMP (2003) set the post-harvest target for CWD at 90% of the weighted average of pre-harvest CWD volume across their blocks (Canadian Forest Products Ltd. 2003). They also had an objective of leaving less than one percent of merchantable wood on site.

Alberta Harvest Planning and Operating Ground Rules Framework for Renewal (Alberta Sustainable Resource Development 2008)

The Ground Rules are the practices used in planning and conducting timber harvesting operations in Alberta. They are the methods used to implement the Forest Management Plan (FMP) and other higher-level plans such as the Integrated Resource Plans (IRPs). The Ground Rules exist to establish practices that minimize negative impacts from roads, timber harvesting, and forest management activities. This would include forest biomass harvesting.

The 2008 Ground Rules state that forest operators are permitted to leave merchantable volume in harvest areas if the approved FMP identifies specific stand structure retention strategies, otherwise the utilization standards apply. In British Columbia, licensees can also apply to leave merchantable volume if they have a justifiable reason, but again it must be approved. The merchantable volume left behind would then presumably be ineligible for forest biomass harvesting.

Section 7.3 of the Ground Rules deals with Debris Management and Wildfire Protection. The Ground Rules recognize that "some retention of debris is valuable from an ecological perspective and that a reasonable amount of debris retention shall occur to emulate natural forest floor accumulations." The concept of mimicking the natural occurrence of woody debris is seen in guidelines for other jurisdictions (e.g., Ontario). "Ecological benefits include microtine habitat, furbearer habitat (when piled), and soil nutrient inputs." Under this section the Ground Rules specify that debris or slash accumulations resulting from logging must, as a priority, be redistributed or disposed of to minimize the risk of wildfire ignition and spread. The rules indicate that the slash redistribution/disposal should be done with consideration to the ecological value of retaining some debris. When debris is maintained, it must be in such a distribution and amount to minimize wildfire risk as a priority, minimize the loss of productive land base lost (i.e., through loss of plantable spots

or area for deciduous tree suckering), and provide ecological benefits. Slash accumulations resulting from timber harvesting, road building, and campsite construction must be disposed of within 24 months in a manner acceptable to the Government of Alberta. This implies that forest biomass harvesting would have to be done within 2 years of logging.

Ground Rules for soils are in Section 9.0. The purpose of the rules is to ensure that timber harvest, road construction, reforestation, and reclamation operations are done in a way that will minimize the potential for soil erosion, prevent soil, logging debris, and deleterious substances from entering watercourses, and ensure that the capability of the site to support healthy tree growth is maintained. The Ground Rules, which are written for conventional logging, are:

- Areas susceptible to rutting, puddling, or compaction shall be avoided when planning temporary roads, decks, landings, and skidding patterns;
- Areas susceptible to rutting, puddling, or compaction shall be harvested during dry or frozen conditions (e.g., areas with predominantly imperfectly–poorly drained soils);
- The total area covered by temporary roads, rutting, bared landing areas, displaced soil, and debris piles created by timber harvesting operations shall not exceed 5% of each harvest areas without prior approval of Alberta;
- Operations shall not occur during heavy rainfall or when the soil is saturated;
- Machine traffic must be minimized on sensitive areas (soil susceptibility to disturbance is determined by a hand test);
- Operations must cease when multiple ruts are created as a clear result of operating during unfavourable ground conditions. Ruts are defined in the Alberta Soil Conservation Guidelines; and
- Erosion and soil disturbance must be minimized, with effort made to retain organic matter and soil nutrients.

Section 11.0 specifies several ground rules for planning, construction, maintaining, and reclaiming roads. These include: roads and landings must be constructed to avoid unstable soils, water source areas, springs and seepage areas; and roads, skid trails, and landings shall be placed in locations and constructed so that soil erosion, damage to streambeds, and sedimentation of watercourses is minimized. As previously mentioned, guidelines relating to roads (not including skid trails) are not described in detail in this report.

Ground Rules for Habitat Management (Section 7.0) are set so that timber operations are implemented in a way that ensures that landscapes maintain biodiversity and ecosystem function. The accessed document had minimal rules for this topic (just that adjacent watersheds of small permanent watercourses must have wildlife corridors connecting their uplands).

Requirements for retention of residual structure in logged areas are specified in the FMP, but if it does not provide direction. Section 7.4 of the Ground Rules sets out the requirements, which include:

- The required number of patches of residual structure (depends on block size);

- Leave larger rather than small patches;
- Leave individual stems throughout harvested areas, as available;
- Leave as many individual stems of non-merchantable trees, shrubs, and snags as operationally and silviculturally feasible;
- Where possible, retain residual structure near woody debris piles (and vice versa), near the harvest area boundary to create a gradual ecotone between forest and the logged area, in patterns and locations that minimize the potential for blowdown, near ephemeral draws and intermittent streams, and within inoperable areas; and
- Stubs may be created anywhere in the logged area to supplement snag densities, aid in windfirmness of residual patches, or for use as rub posts.

It is not apparent in the Ground Rules whether residual structure that blows over may be removed.

The 2008 Watershed Protection Ground Rules (Section 6.0) specify the buffer zones and allowable tree felling and machine operation within riparian areas for seven different classes of waterbodies (too detailed to list in this report). Trees can be felled in riparian areas in some cases but must not enter the watercourse. If slash or debris falls in the watercourse, immediate removal without a machine is required. Equipment is permitted in riparian areas of intermittent or ephemeral streams but only in dry or frozen conditions. Measures must be taken to control erosion and sedimentation into watercourses or waterbodies, and sediment, logging debris, or deleterious substances (e.g., oil) must not be deposited in waterbodies or watercourses, during road construction, maintenance, harvesting, and reclamation or silviculture activities. Equipment may cross watercourses only at approved crossings, and logs may not be decked in watercourses, riparian areas, or seepage areas. Harvesting is not permitted in water source areas in non-frozen conditions. All of these rules are written for conventional logging but would apply to forest biomass harvesting.

Timber Harvest Planning and Operating Ground Rules (Alberta Environmental Protection 1994)

These older Ground Rules specify that harvesting operations must be conducted in ways that encourage richness of wildlife species by maintaining or enhancing habitat diversity, manage for a well-distributed habitat capable of providing long-term population viability for all seasonal and year-round resident wildlife species, and protect fish habitat. Dead standing trees and some live trees should be left for snag recruitment (8 per ha) in the cutblock to provide habitat wherever this does not jeopardize worker safety. Large-diameter dead and selected live trees of unmerchantable species should be identified as a high priority for retention. Trees are preferred in a clumped distribution. Scattered pieces of large woody debris (8 cm diameter and greater) should be retained within cutblocks for small mammal habitat. Piles of large woody debris should be left within cutblocks to provide denning sites for furbearers and their prey species, and cover for small mammals and birds. The piles should be randomly located in the cutblocks (approximately 50 m apart). For fire protection the piles should be at least 8 m from cutblock edges.

The rules recognize the value of woody debris for wildlife, but do not mention other values.

The Ground Rules also state that planning for reforestation and harvesting should be co-ordinated to minimize soil erosion, soil compaction, and watercourse sedimentation. There are also standards for understorey protection, activity in riparian areas, and road building and maintenance. All of these would have relevance to forest biomass harvesting.

Debris Management Standards for Timber Harvest Operations (Alberta Sustainable Resource Development 2010)

This policy, set by ASRD, gives standards for debris management in timber harvesting operations, in compliance with the *Forests Act* and the *Forest and Prairie Protection Act*. In addition to the management of debris for disposal, the standard also applies to debris retained for reforestation, wildlife habitat, or other landscape management objectives. It is clearly stated that debris management must not conflict with other landscape objectives. For example, the loss of productive land due to debris piles, roads, and landings must not exceed the specifications in the Operating Ground Rules (5% of block area). The standards in this document are separated into four sections: (1) Mountain Pine Beetle Control Debris Management Standards; (2) FireSmart Debris Management Standards; (3)Wildlife Habitat and Biodiversity Debris Management Standards; and (4) Reforestation Debris Management Standards. Each standard is summarized below:

1. Mountain Pine Beetle Control Debris Management Standards

   The goal of these standards is to effectively manage debris so as to minimize the risk of mountain pine beetle population spread. This is accomplished by removing and burning woody material in areas of rapid spread (as defined by the Ministry of Sustainable Resource Development). If infested piles cannot be burned by June 15th of each year before beetles disperse, baiting may be used instead as long as the operator can provide evidence to the Ministry that the piles could not be burned. This rule puts a restriction on the availability of road residues.

2. FireSmart Debris Management Standards

   The goal of these standards is to reduce the risk of wildfire to communities or to other values in the forest. For example, within the FireSmart zone (approximately 10 km radius from a community) debris management strategies must not include the retention of any debris piles for reforestation, wildlife habitat, or other landscape management objectives. Outside the FireSmart zone debris pile retention for these objectives may be acceptable but approval is needed from the SRD Area Forestry Manager through Annual Operating Plans, and in accordance with the Wildlife Habitat and Biodiversity Debris Management Standards. Residues would therefore be available for a short time after logging.

3. Wildlife Habitat and Biodiversity Debris Management Standards

   Under these standards, debris piles that are outside of the FireSmart Zone and are retained for wildlife habitat or landscape biodiversity objectives must adhere to the following guidelines. If the strategy involves random scattered piles throughout the harvest area, piles must not exceed 2 m in height or 3 m in width at the base. Distance between piles and from the block edge must be at least 25 m. The guidelines are the same if the random scattered piles are made up of chip residue, except that the piles must be at least 15 m apart, rather than 25 m. If the strategy involves piling of debris at the roadside, piles can only be left along roads scheduled for reclamation and abandonment following the completion of reforestation (scarification, planting). Piles must be compacted to a maximum size of 2 m in height, 3 m in width, and 12 m in length, and must be oriented perpendicular to the road. A group of piles may consist of a maximum of five piles with a 6-m slash-free area between each pile in the group. Pile groups must be separated by a 50-m slash-free area. Again, debris piles would have to be removed soon after logging.

4. Reforestation Debris Management Standards

   Debris or windrows created from reforestation operations must adhere to the following specifications: if the operation results in debris piles, the standards are the same as for random piles retained for wildlife habitat or biodiversity. If the strategy results in windrows (large logs, humus, and duff), windrows must not be greater than 2 m high, 3 m wide, and 75 m in length, must have a slash-free spacing of 8 m, and distance from the block edge must be at least 25 m. Debris piles must be "disposed of" within the 2-year timeline set by the *Forest and Prairie Protection Act*, with a possibility of a 1 year extension if drought conditions prevent burning.

5.2.8 Guides

Preventing Soil Compaction and Rutting in the Boreal Forest of Western Canada: A Practical Guide to Operating Timber Harvesting Equipment (Sutherland 2003)

These are guidelines (not regulations) regarding equipment and operating techniques to avoid damage (compaction or rutting) to forest soils. The soils that are most easily compacted are medium- to fine-textured with a moisture content at or near field capacity and soils most easily rutted are medium- to fine-textured saturated soils, and organic soils with a well-decomposed surface organic layer. The guidebook describes appropriate equipment, skidding and forwarding techniques, timing of operations, and wood-handling techniques at the roadside, but these guidelines are too detailed to summarize here. The guidelines would be relevant to forest biomass harvesting.

Forest Soils Conservation (Alberta Forest Products Association and Alberta Land and Forest Service 1994)

This report provides guidance to planners and operational people regarding potential impacts of roads and decking areas, skidding, and site

preparation on forest soils. The focus is on rutting. Risk ratings for soil rutting are calculated based on the combination of soil texture, water content, and the position of the soil in the landscape. The greatest risk factors contributing to formation of ruts are organic, wet soils, and steep sites (>30%). Intermediate risk factors are fine-textured, moist mineral soil and flat and concave slope positions. The least potential for rutting is associated with coarse-textured mineral soil (less than 20% silt and clay), frozen or dry soil, gentle slopes, and convex slope positions. Operations are recommended to temporarily cease when the risk of soil rutting is high. When the potential is intermediate, wide-tired skidders should be used, and when the potential is low, no machine or forest operation is expected to form ruts.

Roads (including temporary ones) and road areas (stripped landings and bared soil) in Alberta may not make up more than 5% of the total cutblock area. Soil disturbance, such as displacement, compaction, or rutting from harvesting activities, may not exceed 2% of the block area. Ruts are defined as being 4 m long, and >20 cm deep for organic soils, and 10 cm deep into mineral soil when the organic layer is < 30 cm thick.

Field Guide to Eco-sites of West-central Alberta (Beckingham et al. 1996)

In this ecosystem classification field guide, management interpretations are made for drought, excess moisture, soil rutting hazard, soil compaction hazard, puddling hazard, soil erosion hazard, frost heave hazard, soil temperature limitations, vegetation competition, and windthrow hazard. The guide does not include recommendations for forest biomass harvesting specifically.

5.2.9 Protected areas legislation Alberta's parks and protected areas are managed under these pieces of legislation: the *Provincial Parks Act, the Wilderness Areas Act, Ecological Reserves Act, Natural Areas and Heritage Rangelands Act,* and the *Willmore Wilderness Park Act.* The *Provincial Parks Act* (Statutes of Alberta 2000) specifies that timber or other natural resources may not be removed from a Provincial Park, except if it is specifically allowed as part of work being undertaken as part of a disposition (which the Minister can grant). There are several other kinds of protected areas besides parks in Alberta. Logging is not allowed in Ecological Reserves, Wildland Parks, Wilderness Areas, or Natural Areas.

5.3 Saskatchewan

5.3.1 The forest biomass resource In 2009, Saskatchewan had the smallest logged area and volume harvested for a province in Canada (7 920 ha; 1.8 million m^3), except for Prince Edward Island (Natural Resources Canada 2011b). It was estimated to have 0.743 million PDT p.a. in roadside residue, which is about 5% of the amount in British Columbia (Bradley 2010).

5.3.2 Land ownership Ninety percent of Saskatchewan's forest land is publicly owned (4% Federal, 6% private) (Natural Resources Canada 2011b); this section only discusses policy and guidelines in place for Crown land.

5.3.3 Status of forest biomass harvesting policy This and the following section are based on information provided by Larry Stanley (pers. comm, May 9, 2012). Saskatchewan currently has no specific forest biomass harvesting policy but it is at the cusp of development. The government has

been talking with the forest and bioenergy industry for several years, but has not yet gone public about a potential policy and so no information is available. At present, all the government is really saying publicly is that the projected electricity to be generated from forest biomass for operations and sales to the grid is 80 MWs.

5.3.4 Existing forest biomass harvesting industry The main driver behind the use of forest biomass for power in Saskatchewan is the industry's own need to realign their economics and develop a new product line following the downturn of the traditional forest industry. Government goals to produce a certain percentage of energy from renewable resources are not a key factor in development of the industry. SaskPower is in the process of entering into agreements with industry for two to three major projects for use of forest biomass for power for their mills as well as for electricity sold to the grid. An agreement with Paper Excellence in Prince Albert is in the final stages, whereas agreements for the other two are still being worked on and the projects will not be up and running until 2013 for one, and if it goes ahead, 2015 for the other. The industry is too small for a bid process to be in place. In Saskatchewan the primary source of biomass for energy production is residue from mills and to augment that, waste from heritage piles at mills, which are estimated to last for 5 years. The secondary source is roadside residue from logging operations, which is under active discussion, and is expected to be used soon. The tertiary source is residual standing wood that is below the merchantable size, as well as debris from silviculture operations. The final source is material from urban construction or horticultural cuttings, but its use is quite far from becoming a reality. There is also a substantial economic opportunity for harvest and use of fast-growing purpose-grown biomass, which would not be a reality in the next 15 years, but is being looked at by the University of Saskatchewan.

5.3.5 Energy strategies, initiatives, and policies

Saskatchewan Energy and Climate Change Plan (Province of Saskatchewan 2007)

> In this plan, the Saskatchewan government set an ambitious target to reduce GHG emissions. The plan has five components: (1) conservation and efficiency measures by industry, business, and homeowners; (2) carbon dioxide capture and storage measures in Saskatchewan's oil and gas industry and in the province's electricity sector; (3) increased use of renewable energy, including wind, solar power, and hydrogen, and further development of Saskatchewan's ethanol and biodiesel resources; (4) reduction of methane and other emissions in the oil and gas industry, and methane and nitrous oxide emissions in the agriculture industry; and (5) creation of more natural carbon sinks in Saskatchewan's forests and soils. Forest biomass was not specifically mentioned in the plan.

Management and Reduction of Greenhouse Gases Act (Statutes of Saskatchewan 2009)

> This act is a plan to reduce GHG emissions to meet provincial targets and promote investments in low-carbon technologies. Regulated emitters are required to reduce annual emissions by a defined amount, and those with GHG emissions that exceed the target must make a carbon compli-

ance payment to the Saskatchewan Technology Fund. The fund is used to finance investments in low-emitting technologies and processes that reduce GHG emissions. Under the act, the Climate Change Foundation was established to promote research and development and demonstration of low-carbon technologies, encourage adaptation, and increase public education and awareness.

Minister's Task Force Report on Forest Sector Competitiveness (Province of Saskatchewan 2006)

This report was not too optimistic about using forestry biomass as a source of energy. The estimate of the volume of recoverable harvesting residue normally burned on site is estimated at 200 000 to 400 000 green tonnes per year in Saskatchewan, but this report stated that the present technology for generation of electricity using wood waste was not profitable at existing power prices. It reported that the Province needed a solution to this and recommended that SaskPower institute a policy for the long-term purchase of "green" electricity produced from wood waste at a sufficient out-of-market premium to allow for profitable co-generation, and/or construct its own co-generation facilities, and/or provide low-interest loans or grants for capital costs associated with private construction of wood residue co-generation facilities.

Powering a Sustainable Energy Future (SaskPower 2011)

This document is also reserved in its outlook on biomass as an energy source. It outlines SaskPower's electricity and conservation strategy which includes consideration of biomass for energy production, including woody plant matter, agricultural residues, urban and industrial organic wastes, and energy crops. It identifies biomass as an energy source of interest because it can be renewable, sustainable, and nearly carbon-neutral but lists five disadvantages: its limited scale, cost, fuel supply risk, technology still developing, and emissions other than GHG.

Building Saskatchewan's Bio-economy: A Life Sciences Strategy (Ag-West Bio Inc. 2007)

This strategy has a more positive outlook regarding expansion of the bio-economy in Saskatchewan. Twenty recommendations are provided to help Saskatchewan grow its bio-economy, which the document describes as "using renewable feedstocks and biological systems to achieve economic objectives in a way that is sustainable." Saskatchewan is identified as having the potential to be a bio-economy leader because of its reliable access to large volumes of agricultural and forestry biomass, its strong research capacity related to bio-fuels, bio-products, and bio-processing, a knowledgeable workforce, and an export focus. The bio-economy provides the opportunity to "increase the revenue for primary producers, improve the sustainability of rural communities, create new high-value jobs and have a positive impact on the environment."

Go Green Fund (www.environment.gov.sk.ca/go-green/fund)

This is a government fund to assist communities, non-government organizations, businesses, and citizens in Saskatchewan in addressing important environmental issues in the province. The initiative supports "practi-

cal, cost-effective solutions delivered through innovative environmental technologies, processes and improved public understanding." Projects that may be funded include those that meet the objective of reducing or avoiding GHG emissions. However, it is not specifically aimed at natural resources and the emphasis has shifted to energy efficiency projects. No forest biomass projects have come out of it (L. Stanley, pers. comm., May 9, 2012).

5.3.6 Policies and strategies related to sustainability

Long-Term Integrated Forest Resource Management Plan (Saskatchewan Environment and Resource Management and Natural Resources Canada–Canadian Forest Service 1996)

The concept of integrated forest resource management (IFRM) in Saskatchewan was brought forward in the Long-Term Integrated Forest Resource Management Plan, prepared by Saskatchewan Environment and Resource Management, in co-operation with Natural Resources Canada–Canadian Forest Service. Integrated forest resource management was defined as "managing the whole forest ecosystem, including soil, water, trees, animals, and plants, to meet a variety of objectives." A broad range of resource users were intended to be given the opportunity to be involved in management planning. Objectives included "retaining soil fertility and natural processes while managing forest resources" and "maintaining native biological diversity and forest productivity as a goal of reforestation." The overall goal of the plan was adapted from the Canada Forest Accord: "Our goal is to balance the need to maintain and enhance the long-term health of our forest ecosystems with the need to provide economic, social, and cultural opportunities, for the benefit of present and future generations." Atkinson (1995) describes the steps leading to the plan and her perspective as the plan was first being implemented. Once the second draft was done, Cabinet would not endorse the total plan because of its complexity and potential financial implications (Atkinson 1995), so based on the Plan, Saskatchewan's Forest Management Policy Framework was developed and approved by Cabinet in February 1995.

Forest Management Policy Framework

The policy framework was not nearly as detailed or far-reaching as the Forest Resource Management Plan but committed Saskatchewan to principles such as stewardship of forest ecosystems, sustainable use of forest resources, environmental protection, and public involvement (Atkinson 1995). The Plan was made available to the public in May 1995. The framework laid out a set of directions intended to guide forest management in Saskatchewan toward the overall goal of sustainable forest management. Saskatchewan's vision for sustainable forestry was identified by statements including "our forests will be maintained in a healthy state, and the natural variety of life will be conserved" and "we will balance the need for protection with the opportunities for use, and resources will be harvested no faster than they can be renewed."

2009 State of Saskatchewan's Provincial Forest (Saskatchewan Ministry of Environment 2009)

A recent assessment of Saskatchewan's success in achieving sustainable forest management is outlined in the Ministry of Environment's 2009 State of Saskatchewan Provincial Forest report, which concludes, based on an assessment of 23 sustainable forest management indicators, that although there are shortfalls, overall the results have been positive. The Ministry, including the Forest Service, is now implementing a new results-based approach to forest management, taking the focus off prescriptive regulation and processes and onto desired environmental and resource management outcomes.

Conservation Strategy for Sustainable Development in Saskatchewan

Around the time the Forest Resource Management Plan was implemented, other agreements, plans, and strategies were developed by various levels of government that are relevant to management of forest resources (Atkinson 1995). The common theme in these agreements was to achieve sustainable resource development. The Conservation Strategy for Sustainable Development in Saskatchewan (Saskatchewan Round Table on Environment and Economy 1991) was developed by the Saskatchewan Round Table on Environment and Economy in response to the recommendations of the World Commission on Environment and Development. It set a number of biodiversity-related recommendations including ensuring that government agencies take into account biological diversity in their planning and day-to-day activities.

5.3.7 Natural resource legislation

Natural Resources Act (Statutes of Saskatchewan 1993)

The *Natural Resources Act* establishes the province's mandate to manage, protect, conserve, and develop renewable resources in a sustainable manner.

Forest Resources Management Act (FRMA) (Statutes of Saskatchewan 1996)

Saskatchewan's forest resources are administered under the provincial FRMA, which was created as the first concrete step in the implementation of the Forest Management Policy Framework. FRMA allocates timber through Forest Management Agreements (FMAs), Term Cutting Licences, and Timber Permits. The purpose of the act is "to promote the sustainable use of forest land for the benefit of current and future generations by balancing the need for economic, social and cultural opportunities with the need to maintain and enhance the health of forest land."

FRMA stipulates that "no person shall harvest or acquire any right or property in any forest product except in accordance with this Act or the regulations." Forest products are defined as "all vegetation on or from forest land or waters or associated with forestland, whether alive, dead or cut, and includes trees, shrubs, herbs, grasses, mosses, fungi or any parts or components of that vegetation." This would include woody forest biomass.

Forest Resource Management Regulations (Statutes of Saskatchewan 1999; amended 2007)

The Forest Resource Management Regulations under FRMA specify obligations of licensees, include the requirement that every operating plan must include a description of ". . . harvesting, renewal, maintenance and protection activities that will be used to ensure that the forest in the operating areas will be renewed and maintained, methods for managing or disposing of logging slash, and activities for decommissioning and reclamation."

Legislated Manuals (Saskatchewan Ministry of Environment 2004; 2007a,b)

Saskatchewan Environment (SE) has been developing four manuals in accordance with FRMA to provide guidance for forest management activities in Saskatchewan. They are the Forest Management Planning Manual, Forest Operation Manual, Compliance Manual, and Scaling Manual, and include objectives, standards, guidelines, and procedures for licensees when undertaking forest operations. An objective is defined as a statement of a desirable forest practice or future condition of a forest resource or forest use, which is attainable through actions of the licensee. The objective sets the context and rationale for developing procedures, standards, and guidelines. A standard is a specific measurable activity, result, or unit of measure that is enforced by SE. Guidelines are recommended practices and are options for achieving standards and objectives given expected conditions. A licensee may deviate from the guideline when unforeseen or site-specific circumstances require an alternative approach. Although SE will not enforce guidelines, their effectiveness or use of alternative practices will be considered in audits. A procedure is the sequence of actions used to ensure consistent assessment of standards across the province and concentrates on methods rather than results. SE may require that a specific procedure is followed.

The Forest Management Planning Manual is a 251-page document containing requirements and recommendations when preparing a forest management plan, including requirements for ecosystem-based and sustainable management. There appears to be no specific reference to woody debris management in the manual. The Forest Operations Manual was not available online at the time this report was prepared.

5.3.8 Forest Management Agreements

Standards and Guidelines for Forest Management Agreements

In addition to the four manuals described above, standards and guidelines specific to each Forest Management Agreement have been developed with industry, and are reviewed annually or biannually. These standards will be replaced with chapters of the Saskatchewan Environmental Code as they are developed. An example of the standards and guidelines is the one for the Pasquia-Porcupine Forest Management Agreement Area (Saskatchewan Ministry of Environment 2011), which includes the following standards and guidelines that have relevance to woody forest biomass harvesting:

Utilization

- All blocks must be harvested in a single entry, whereby all merchantable trees will be utilized, with the exception of the approved merchantable tree retention targets; and
- All merchantable trees harvested shall be utilized as per the licensee's 20 Year Forest Management Plan, Forest Management Agreement, and approved operating plan.

Woody debris

- Slash management is done with the objective of assisting in maintaining the productivity of forest sites;
- Slash derived from road and harvesting operations is to be managed in manner that minimizes impacts on wildlife habitat and travel, assists in meeting reforestation objectives, takes into account soil protection, considers aesthetics, and reduces the potential for escape fires or fire spread;
- Slash must be re-spread on blocks within 2 years of harvest;
- Priority should be placed on spreading versus burning of slash and it should be spread evenly throughout the harvest block within the harvest season;
- Either delimb at the stump or roadside and redistribute;
- Recommendations for slash disposal/redistribution are made for various stand types:
    - Jack pine: Consider re-distributing slash back into the cutblock (where delimbing is done at roadside) or leaving slash in the cutblock (where delimbing is done "at the stump") on sites where natural regeneration is prescribed in the Site Prescription. Where harvesting has been conducted during the winter, delimbing at the stump or re-distribution of the slash may not be necessary for natural regeneration if an adequate supply and distribution of cones has been left on site;
    - Hardwood stands: Where roadside delimbing/topping occurs, the slash can be spread evenly throughout the harvest block (provided future and advanced regeneration is not impeded) and/or be piled and burnt. Hardwood sites that have been de-limbed/topped at the stump will be assessed to determine if further re-distribution of top piles is required to ensure that stocking standards are achieved; and
    - Mixed-wood stands: Where artificial regeneration is prescribed, consider piling and burning slash, or re-distributing slash onto roads, landings, and/or across the cutblock, or a combination of these methods.

Soils

- Assess low-nutrient sites, such as shallow soils over bedrock or coarse soils, to determine if further re-distribution of slash throughout the cutover is required to return nutrients to the site;
- Rutting in any soil type shall not exceed 15 cm in depth and 5 m in length, and must not occupy more than 1% of the portion of harvest block surveyed (minimum 4 ha);

- Minimize the amount of skid trails, using an average skidding distance of 200 m as a guide;
- In-block roads and stumped landings must be reclaimed with 2 years of harvesting;
- Minimize soil compaction by limiting heavy equipment traffic on soils during wet soil conditions;
- Use high-flotation tires on skidders or use low ground pressure tracked machines to minimize soil compaction and disturbance;
- Follow the Pre-Harvest Silviculture Plan (PHSP), especially in regards to the rutting and compaction hazard for the harvest block, as well as the prescribed season of harvest; and
- Forest operations should be scheduled during the appropriate seasons to minimize the potential of rutting and compaction.

Tree retention

- A minimum of 2% cover (or 2% volume) in individual trees and clumps of trees should be retained across the harvest block except for blocks less than 20 ha in area. The PHSP must specify how the trees will be left (e.g., individual trees, clumps, islands);
- A minimum of 2% cover should be left at the landscape scale for the 10-year period of the current FMP;
- Green-tree retention must be in accordance with the *Occupational Health and Safety Act;*
- Residual trees left for wildlife ideally should be large-diameter, windfirm and high-quality for cavity trees or those with potential to form cavities. These trees will provide some residual semblance of the structure that would be left after a fire and provide a source of future dead and down woody debris; and
- Patches should include trees of good health, vigour, and form.

Hydrology/riparian areas

- Lakes and streams not capable of supporting fish and not connected to a recognizable stream system require no riparian reservation;
- Small streams that are a part of a recognizable stream system, but do not support permanent or seasonal populations of fish, require a riparian reservation of 15 m;
- Lakes and streams with seasonal populations of fish require a riparian reservation of 30 m;
- Lakes and streams with permanent fish populations, or capable of supporting a fish population introduced by stocking, require a riparian reservation of 90 m;
- Except for approved watercourse road crossings, approval to conduct forest operations within 15-m buffers must be obtained from the Inspecting Officer. Approval must be obtained from the Area Fisheries Biologist for activities within 30- and 90-m buffers;
- Deviations in riparian management area standards, for the purpose of addressing forest health issues or blow down salvage harvesting, may be approved;
- Requests for deviations in riparian management areas must be included in the PHSP for harvest blocks, or in operating area write-ups for road rights-of-way outside of harvest blocks;

- Deleterious substances must not be deposited in fish streams, or streams that flow into fish habitat;
- The bed, bank, or boundary of watercourses and waterbodies must not be altered, sand, gravel, or other material may not removed, displaced or added to these areas, and vegetation must not be removed;
- Roads should be planned to minimize the number of stream crossings and length of time culverts are in place; and
- Recommendations for locating stream crossings are provided.

Objectives in the 20-year management plan include:

- Maintain and enhance the long-term health of the forest ecosystems;
- Protect the primary resources of air, water, and soil;
- Prevent losses of soil productivity resulting from nutrient depletion during harvesting;
- Retain, following the harvesting of trees, sufficient residual structure (snags, live trees, understorey vegetation, and downed woody material) as required for maintenance of ecosystem health (habitat for commercially important wildlife species, habitat for rare and endangered species) and for reforestation;
- Maintain the diversity of life forms in the area, including species, the genes they possess, and the ecosystems they inhabit; and
- Ensure that forest areas are regenerated after harvesting, and that future harvests can be sustained in perpetuity at or above natural levels of timber production.

5.3.9 Guides

Field Guide to the Ecosites of Saskatchewan's Provincial Forests (2010)

Saskatchewan has developed an ecosystem classification system for the site level (McLaughlan et al. 2010), which includes ecological interpretations but no management interpretations nor reference to woody forest biomass.

5.3.10 Protected areas legislation The *Parks Act* (Statutes of Saskatchewan 1986) specifies that logging is permitted in provincial parks, in accordance with the *Forest Resource Management Act*.

5.4 Manitoba

5.4.1 The forest biomass resource In 2009, Manitoba harvested a similar volume of wood to Saskatchewan (1.84 million m^3) although the harvest area was twice as large (13 648 ha) (Natural Resources Canada 2011b). The province is estimated to have 0.329 million BDT p.a. of roadside residues, which is the least of all provinces except Newfoundland and Labrador and Prince Edward Island.

5.4.2 Land ownership Ninety-five percent of Manitoba's forest land is publicly owned (3% private, 2% Federal) (Natural Resources Canada 2011b). Policies and guidelines described in this section focus on Crown land but guidelines for private land are also described.

5.4.3 Status of forest biomass harvesting policy Manitoba has no forest biomass harvesting policy in place but is considering the development of new policy (J. Epp, pers. comm., Mar. 8, 2013). The *Forest Act* and its regulations specify what merchantable timber is and the amount of material left behind. The unmerchantable wood can be harvested and used as biomass when requested, with authorization. Biomass opportunities are reviewed on a site-by-site basis and further instructions are detailed in the Timber Sale Agreements along with the various permits that are issued.

5.4.4 Existing forest biomass harvesting Forest biomass harvesting is occurring to a minor extent in Manitoba (J. Epp, pers. comm., May 30, 2012). It is done either in conjunction with the issued cutting authority or through timber sales and permits to quota holders or other individuals. Forest biomass is currently being used by logging companies to provide heat and power to their facilities. Smaller operations are producing wood pellets. Biomass harvest opportunities are allocated through public auction or direct award. There are currently two programs to support bioenergy development in Manitoba (E. Lui, pers. comm., June 11, 2012). Manitoba Hydro runs the PowerSmart Bioenergy Optimization Program, which provides technical and financial support to help customers install, operate, and maintain equipment. The Manitoba Agriculture, Food and Rural Initiatives runs the Biomass Enenergy Support Program, which is intended to help replace the use of coal for heating with biomass. The program has two components: (1) a consumer component to assist coal users to purchase approved biomass; and (2) a capital component to assist biomass users and processors to establish or upgrade infrastructure and facilities.

One of the objectives in the Manitoba Bioproducts Strategy (Province of Manitoba 2008b) is "to establish Manitoba's position as the capital of biofibre and biomaterials in terms of research, development and commercialization in Canada." The industry is described as driven by motivation to capture value for the abundance of biomass in the province, sustain Manitoba's needs for renewable energy and materials, reduce GHG emissions, and build stronger communities in rural and northern Manitoba. However, current interest in biomass in Manitoba is limited at this time because Manitoba Hydro rates are low (J. Epp, pers. comm., May 30, 2012).

5.4.5 Energy strategies, initiatives, and policies

Kyoto and Beyond: Meeting and Exceeding Our Kyoto Targets (Province of Manitoba 2002)

> In this Climate Change Action Plan the government optimistically indicated that they could achieve reductions in GHG emissions of up to 18% below 1990 levels by 2010, and reductions of up to 23% by 2012. The 2002 plan was removed from government websites, and the target down-graded to 6% below 1990 levels when the new Climate Change Action Plan, Beyond Kyoto was released in 2008. (www.gov.mb.ca/chc/press/top/2008/04/2008-04-21-100300-3541.html)

Climate Change and Emissions Reduction Act (Statutes of Manitoba 2008)

This act established an emissions reduction target of 6% below 1990 levels by 2012.

Beyond Kyoto (Province of Manitoba 2008a)

This plan contains more than 60 actions to meet Manitoba's climate-change commitments. It focusses on expanding renewable energy, improving energy efficiency, and reducing emissions from the transport and agriculture sectors. The plan is supported by $145 million in funding to meet the commitments outlined in the government's recently introduced climate change legislation. Highlights of these investments include planting 5 million trees over 5 years and making new investments to expand and promote use of biomass as a low-carbon alternative to fossil fuels such as coal.

The Western Climate Initiative (WCI) (www.energymanitoba.org)

The WCI began in 2007 with the joining of governments of six western U.S. states and Manitoba, British Columbia, Ontario, and Quebec to develop regional strategies to address climate change. The initiative included developing a plan to reduce GHG emissions in the west to 15% below 2005 levels by 2020. The strategy included using a cap-and-trade system using market principles to reduce GHG emissions. "The system works by setting an overall cap on the total amount of emissions that are allowed, and then lowering the cap over time to reduce overall emissions. GHG emitters in the system are issued emission allowances that add up to the total allowable emissions for the province under the cap. When emitters have excess allowances, they will be able to sell them to those that produce more emissions than they're allotted. In this way, the cap and trade system uses the marketplace to reward efficiency and innovation; those that are most efficient will profit from reducing their GHG emissions." (www.env.gov.bc.ca/cas/mitigation/cap_trade.html). Manitoba conducted a public consultation on using cap-and-trade as a mechanism to reduce the province's GHG emissions, and expects to join the WCI cap-and-trade system after 2012, pending review of the consultation outcomes.

Energy: Expanding Clean Energy and Energy Efficiency–Manitoba Helping the World (Province of Manitoba 2008c)

This is a component of Next Steps: 2008 Action on Climate Change (Province of Manitoba 2009), providing funding to expand opportunities to use biomass as an alternative energy source in Manitoba. On Earth Day in April 2009, the Manitoba government announced a plan to provide funding to accelerate plans for production of heat and power from agricultural and forestry bioproducts. A total of $895 000 was set aside for programs that use crop and forestry by-products as heat and power sources to reduce or eliminate the use of fossil fuels. The Minister of Agriculture, Food and Rural Initiatives (MAFRI) stated "Biomass products are an important link in the value-added chain as the agriculture and forestry sectors benefit financially by selling their by-products to companies that redevelop them into new products." "With innovation,

many biomass products are becoming cost competitive with fossil fuels and are more environmentally friendly." The MAFRI was to work with Manitoba Science, Technology, Energy and Mines under the biomass energy initiatives and crop residue burning mitigation program to provide: (1) $150 000 for a feasibility study using wood biomass for heating and power; (2) $100 000 to develop the Manitoba biomass energy strategy to accelerate the displacement of fossil fuels for heating and transportation; (3) $65 000 to assess the feasibility of converting the Pine Falls paper mill and other large industries to biomass energy; (4) $100 000 to assess the feasibility of implementing biomass energy at Assiniboine Community College; and (5) $30 000 for a project to provide an alternative to burning crop residue on fields.

Bioproducts Strategy (Province of Manitoba 2008b) (www.gov.mb.ca/agriculture/pdf/the_manitoba_bioproducts_strategy.pdf)

This is a government strategy for further development of the sustainable production of Manitoba's renewable resources. Many objectives and actions are put forth, including plans to develop policies related to bioproducts. Their commitments in this regard include developing "an integrated biomass production and land use strategy that identifies ecological and energy-efficient biomass production systems on a district or regional basis and that recommends policies (e.g., guidelines, incentives, extension) to enable profitable and sustainable biomass supply." Objectives of the strategy include:

- Sustain the bioproducts industry's needs for feedstock without tempering the environment and food supplies;
- Facilitate the conversion of agriculture and forestry biomass into bioenergy;
- Increase the availability and use of biofuels to reduce reliance on imported forest fuels;
- Reduce GHG emissions from the use of fossil fuels in the energy sector;
- Advance the research and innovation capabilities for production, processing, and industrial applications of biofibre and biomaterials; and
- Increase the use of biofibres and biomaterials in the manufacturing sector.

The document lists numerous actions that reflect Manitoba's strong commitment to use of bioproducts including woody forest biomass, such as:

- Develop inventories of biomass from sources including forestry waste;
- Develop inventories of current practices and/or technologies used for harvesting, and post-harvest handling including transportation and storage of biomass;
- Assess the long-term impact of climate change on Manitoba's biomass production and availability and development of action plans to mitigate associated risks;
- Support innovation and commercialization of energy-efficient and cost-effective biomass harvesting and post-harvest handling;

- Support workshops that facilitate new thinking on forestry practices;
- Support research and development and commercialization of clean and energy-efficient biomass combustion technologies;
- Work with private and public stakeholders to develop and establish standards and certification programs for biomass solid fuels and combustion appliances;
- Support biomass to heat and power projects for off-grid and northern communities in Manitoba;
- Conduct a financial and economic feasibility analysis of biomass for heating and power for the primary forest products industry;
- Establish an organization responsible for implementing the strategy;
- Invest in research, innovation, and commercialization;
- Create a skilled workforce;
- Support market development; and
- Increase public awareness.

5.4.6 Natural resource legislation

Forest Act (Statutes of Manitoba 1988a)

All but 5% of Manitoba's forests are on provincial Crown land (Natural Resources Canada 2011b) and the responsibility for their management lies with the Forestry Branch within Manitoba Conservation. Forestry activities on this Crown land are regulated under the provincial *Forest Act* (Statutes of Manitoba 1999) and provincial *Environment Act* (Statutes of Manitoba 1987). Woody forest biomass harvesting is not specifically mentioned in these acts, or in the *Sustainable Development Act* (Statutes of Manitoba 1997), but they all set out requirements that would relate to it. Under the *Forest Act,* companies that hold or are seeking a Forest Management Licence are required to develop long-term Forest Management Plans, which must be in accordance with current guidelines provided by Manitoba Conservation (see below). Timber Sale Agreements are a second type of tenure, which specifies the wood volume to be harvested, the specific locations to be harvested, and any special conditions for that harvest. For these the responsibility for forest management planning is usually assumed by Manitoba Conservation. Timber Permits are for small (< 300 m^3) volumes and forest management plans are made by Manitoba Conservation. The *Forest Act* states that "the minister, with respect to Crown timber on behalf of the Crown, shall regulate and administer all matters relating to, or in any way connected with forestry, and, without restricting the generality of the foregoing, shall regulate and administer: (1) all rights, properties, interests, claims and demands of the Crown in timber; (2) subject to the *Financial Administration Act,* all revenues and money of the Crown arising from forestry; (3) management, utilization and conservation of Crown forest lands and timber; (4) afforestation, reforestation, tree preservation and tree improvement; (5) the disposition of timber; (6) the cutting and production of primary forest products and products of the forest; and (7) the enforcement of statutes, rules and regulations relating to forestry and provincial forests."

Forest Use and Management Regulation (FUMR) (Statutes of Manitoba 1988b)

The focus in this regulation of the *Forest Act* is on the removal, not retention, of debris. Section 10(1) of FUMR specifies: "The method of disposal of brush and other logging debris on timber cutting operations shall be designated by an officer in advance of the cutting operation and brush disposal shall keep pace with the timber cutting operation," and in Section 10(1.1): "An operator who fails to dispose of brush or other logging debris in accordance with subsection (1) shall pay a penalty that is calculated by assessing twice the rate of dues and charges payable under the timber cutting right on an officer's estimate of the gross volume of brush or debris that was improperly disposed."

All merchantable portions must be taken from the trees cut, leaving no waste timber, and any merchantable waste is subject to a penalty, which is: (1) Exceeding the maximum allowed stump height: $1 per stump plus expenses; (2) Exceeding the minimum diameter: $1 per top plus expenses; and (3) Exceeding the maximum allowed allowance: $1 per log plus expenses.

Environment Act (Statutes of Manitoba 1987)

The intent of the *Environment Act* is to "develop and maintain an environmental protection and management system in Manitoba which will ensure that the environment is protected and maintained in such a manner as to sustain a high quality of life, including social and economic development, recreation and leisure for this and future generations." It complements and supports other provincial plans and policies.

Sustainable Development Act (Statutes of Manitoba 1997)

The stated purpose of this act is to "create a framework through which sustainable development will be implemented in the provincial public sector and promoted in private industry and in society generally." Seven principles of sustainable development are defined by the act, including "Economic decisions should adequately reflect environmental, human health and social effects" and "today's decisions are to be balanced with tomorrow's effects." The Conservation and Enhancement principles state that Manitobans should maintain the ecological processes, biological diversity, and life-support systems of the environment, harvest renewable resources on a sustainable yield basis, and enhance the long-term productive capability, quality, and capacity of natural ecosystems. Thus, forest biomass harvesting is required to be a sustainable operation that maintains biodiversity and productivity.

5.4.7 Guides

Manitoba Conservation Guidebooks

Several guidebooks (listed below), set to be reviewed every 5 years, outline alternatives for operational activities in Manitoba. They have been developed as part of Manitoba Conservation's Forest Practices Initiative. The books lay out flexible procedures or standards that are used to develop prescriptions, and then become enforceable when included in

Work Permits. Those procedures described in the books that specifically relate to woody forest biomass harvesting are summarized below.

Brush Disposal Guidebook (Manitoba Conservation 2005a)

Here the focus is on retention of woody biomass for soils, site productivity, and wildlife. Limbing and topping of trees is recommended to be done as near as possible to the stump, and whole-tree harvesting and removal of branches and foliage from the site is stated to have a negative effect on the balance of the soil nutrient budget. The guide says that on sites with shallow soils, or dry sites with coarse-textured soils, removal of debris may affect soil fertility. This is recognized across Canada and these are sites where forest biomass harvesting should be limited. The guide identifies that long-term studies are needed in the boreal forest to quantify the effects of full-tree harvesting methods on nutrient cycling, soils, long-term productivity, and sustainability of the site. Several studies are already under way and as results become available, brush disposal management strategies will be modified. This could potentially put constraints on biomass harvesting.

The guidebook says that for all sites, maintaining CWD is important for conserving biodiversity. If limbing is done at staging areas, debris must be effectively spread throughout the cutblock, although some debris piles may be maintained for wildlife habitat. If limbing is done at the roadside, debris may be re-spread in the block or roads in the block, put in piles for wildlife habitat, or piled and burned. Integrated Resource Management Teams may allow or require creation or retention of CWD piles in cutblocks with significant marten and other small mammal populations in order to retain habitat and maintain their numbers. The recommended size, density, and location of piles are provided. If this guidebook is followed, forest biomass harvesting would have to retain a certain amount of debris for wildlife/biodiversity.

Forest Management Guidelines for Riparian Management Areas (Manitoba Conservation 2008)

Here guidelines are set out for forest management activities in riparian areas, with an overriding statement that impacts from a reduction in CWD may not be observed for a long time. CWD is identified as a persistent source of carbon and a critical structural feature for steam ecosystems. No activity is permitted within the Riparian Zone (from water's edge to start of merchantable timber), and in the Machine Free Zone (approximately 7 m wide, from the edge of the Riparian Zone back into the timber) machines are prohibited, but reaching in to remove logs is permitted. This would prohibit biomass harvesting in Riparian Zones, but not in Machine Free Zones.

Forest Management Guidelines for Terrestrial Buffers (Manitoba Conservation 2010)

Forest Management Guidelines for Terrestrial Buffers provides minimum buffer widths and other considerations for maintaining important and/or sensitive natural, cultural, and recreational features within managed forests to ensure that these other resource values are sustainable when managing for timber resources. Biomass harvesting operations would

presumably have to be done within the constraints of these guidelines, since the buffers apply to "managing for timber resources" not just conventional logging. Buffer widths for wildlife species including birds, snakes, and mammals range from 50 to 200 m. Buffer widths for other features are: mineral licks and springs, residential and commercial lots, intensive public recreation areas and trappers cabins (50–200 m), research and permanent sample plots (100 m), designated hiking trails (0–50 m), and sink holes in karst topography (15 m). Buffer widths for cultural/heritage sites, provincial parks, protected areas, and native grass meadows are determined by Regional Integrated Resource Management Teams. The requirements for buffers in this guidebook take precedence over those in Forest Management Guidelines for Manitoba (1989).

Protection of Softwood Understorey in Mixedwood and Hardwood Forests (Manitoba Conservation 2003)

Guidelines are provided for protecting the understorey during harvesting operations. Road location, skid trails, and harvesting must avoid clumps of advanced softwood understorey, and operators must leave patches of hardwood around clumps of softwood understorey. If there are significant numbers of blown down or damaged trees after harvesting is complete, Manitoba Conservation will determine whether these trees should be removed based on the merchantable volume, risk of damage to protected trees, ecological benefits of the fallen trees, and other values. Guidebooks specifically addressing understorey protection were not found for provinces and territories other than Manitoba, but some guidelines do exist amongst other recommendations.

Other Manitoba Conservation Guidebooks

The Pre-harvest Survey Guidelines (Manitoba Conservation and Manitoba Water Stewardship 2008) provide operational guidelines to use when doing pre-harvest surveys, which involves collection of information on timber and non-timber values in proposed cutblocks. These surveys are a requirement of the *Environment Act*. The collected information is used to develop harvest and forest renewal prescriptions for annual operating plans, which must "maintain site productivity, reduce resource use conflict, mitigate potential negative impacts, make operations more efficient/effective, conserve biodiversity, and contribute to sustainable forest management." The pre-harvest number of snags per hectare must be recorded by diameter, class, and species, but there are no requirements for CWD information. Manitoba's Submission Guidelines for Forest Management Operating Plans (Manitoba Conservation 2011) outlines the minimum information required of proponents when preparing operating plans, which are the main vehicle for implementing forest management plans on Crown Lands. The guidebook is too general to include mention of woody debris or snags.

Guidelines for Environmentally Responsible Forestry Operations in Manitoba (Peacock 1996)

Guidelines for Environmentally Responsible Forestry Operations in Manitoba is a pictorial guide to sustainable forestry and is based on previous documents produced by the Ministry of Natural Resources.

Recommendations directly related to woody biomass are to leave snags and large cull logs for wildlife, and to limb and lop at the stump to achieve good slash distribution and retain nutrients on the site. These recommendations are general for all sites and do not specify sizes or other attributes of woody biomass to be retained, but they do identify the importance of woody debris for soils and wildlife and are implying that all debris should not be removed.

Forest Ecosystem Classification for Manitoba

Manitoba's ecosystem classification guidebook (Zoladesky et al. 1995) includes information for each vegetation and soil type on commercial forests in Manitoba and is a foundation for ecosystem-based forest management in the province. Management interpretations are made for silviculture (season of harvest, harvest type, species selection, site preparation method, vegetation competition type, and level) and wildlife habitat (caribou forage potential, moose summer feeding potential, moose thermoregulation potential, and moose winter feeding potential). The publication was not obtained in time to check if it includes recommendations that would guide forest biomass harvesting (e.g., recommending against full-tree logging on certain sites).

Harvesting to Regenerate a Natural Forest: Site, Cut-Block and Operating Area Indicators of Sustainable Forest Management. Progress Report (ECOSTEM 2004)

Landscape design and cutblock operating guidelines that describe practices intended to approximate the effects of a large wildfire were developed and tested. They apply to the Manitoba Model Forest in southeastern Manitoba. The overall principle used during development of the guidelines was that operating areas should "look, feel, and operate" like a natural forest as quickly as possible after harvest. The guidelines include the recommendation that woody debris on logged areas should resemble (within 20 years) that which would occur naturally after a large fire, but excessive shading from slash should be eliminated, although at the same time some shade should be provided for seedlings (see below). Knowledge of woody debris levels on natural sites is needed if logged sites are to mimic natural ones. Satisfying the woody debris and all other objectives simultaneously may be difficult when planning and implementing forest biomass harvesting, especially on some sites. However, good forest management is always a juggling act between various objectives. The goals and objectives that were developed are listed below.

Operational goals for timber harvesting at the operating area and cutblock level:

- Minimize the differences in the ways that logging and wildfire initially affect plants, soils, and animals; and
- Minimize the time required for a cutblock to "look, feel, and operate" like a natural forest. That is, minimize the length of time when harvested sites are outside the range of natural variability for species composition, physical structure, and the rates of ecological processes. Harvested sites that represent ecosystems outside the range of natural variability are called divergent sites.

Goals throughout the region:

- Maintain the total area of divergent sites below that which causes regional ecological functions to vary outside their ranges of natural variability;
- Maintain soil fertility at every site (except permanent roads);
- Maintain all sensitive, rare native ecosystems;
- Maintain viable populations of sensitive species; and
- Maintain water quantity and quality.

Ecological objectives for cutblocks:

- Create short-term large downed woody material (DWM) structure;
- Within 20 years, provide continuous large and small DWM at levels that approximate post-fire conditions. Note that, unlike most guidelines, small, rather than just coarse, woody debris is specifically mentioned;
- Create natural snag density by age 20;
- Create dense sapling regeneration;
- Create a favourable seedbed for jack pine, black spruce, and post-fire ephemeral species. On highlands, disturb the lichen/ moss/ duff layer; on lowlands, maintain sphagnum hummocks for jack pine and black spruce seedlings;
- Provide a seed source that reflects natural post-fire species composition;
- Provide shade for tree seedlings;
- Eliminate excessive shading from slash;
- Maintain an even-age structure and natural species composition;
- Prevent shifts in overstorey composition towards aspen or fire intolerant species (e.g., balsam fir, tamarack);
- Promote post-fire ephemeral species;
- Minimize disturbance or compaction of soil other than the forest floor;
- Maximize retention of immobile and mineralized nutrients on site;
- Initiate natural soil nutrient cycling; and
- Distribute benefits widely in cutblocks.

5.4.8 Private land

Managing Your Private Woodlot: A Guide to Best Management Practices (Manitoba Model Forest, n.d.)

This guidebook for private woodlot owners includes many best management practices (not requirements) relevant to forest biomass harvesting:

Woody debris management:

- Woodlot owners are recommended to develop harvesting prescriptions, which include defining standards for merchantable timber, minimum stump heights, and woody debris;
- When feasible, de-limb and top trees at the stump to retain nutrients and seed on site;
- Limbs and tops should be broken down by equipment to maximize soil contact and speed slash decomposition;

- Slash piles should not exceed 1.2 m in height and should not be left around the base of remaining trees; and
- Within Riparian Management Zones slash piles should not be left within 15 m of the high water mark.

Landings and skid trails:

- Use existing skid trails where possible;
- Locate and design skid trails to minimize damage to soils, residual stands, and riparian areas;
- Use designated skid trails rather than random skidding to minimize the amount of area disturbed and compacted;
- Lay out skid trails to minimize the number required. Only 10–25% of the block should be in primary skid trails;
- Use herringbone skid trail design if the area is relatively flat and obstacle free; this reduces tree damage and soil disturbance;
- Skid trails for summer and fall should be in well-drained areas only, to reduce rutting and erosion. If this is not possible, harvest in winter when the ground is frozen;
- On wet or sensitive soils, skid only in winter;
- Consider using skid cones to reduce soil disturbance caused by the logs;
- Ensure skid trail width will accommodate equipment;
- Avoid creating sharp curves. If unavoidable, widen the trail;
- Consider leaving bumper trees or high stumps at corners of trails to reduce damage to standing trees;
- On steep slopes, lay trails out parallel to the contour to minimize erosion. If this is not possible, skid trails should never exceed 30% on unstable soils;
- Minimize the number of landings. Use existing landings where feasible; and
- Locate landings on upland stable ground and outside of riparian management zones.

Wildlife and other environmental considerations:

- Avoid degradation and destruction of wildlife habitat that is protected under the Species at Risk and *Manitoba Endangered Species Act*;
- Retain three hard snags/acre (live trees with rot) or two soft snags/acre (dead standing trees) for nesting, feeding, and escape cover for birds and small mammals. Try to preserve snags with evidence of high use (cavities present);
- Remove hazardous snags;
- Maintain mast trees as a food source for birds and mammals;
- Retain some standing wildlife trees for wildlife purposes. Choose healthy, windfirm trees, preferably in clumps; and
- Retain areas with special resource values: colonial water bird nests, eagle and osprey nests, habitat of endangered species, and recreational areas.

Riparian areas:

- Never clearcut next to a water body or watercourse;
- Leave Riparian Management Zones (RMZs) around all streams, water bodies, or wetlands. Recommended minimum size is 20 m on each side of the water body;
- Restrict harvesting in RMZs to light single-tree selection;
- Consider leaving only windfirm trees in the RMZ;
- Heavy machinery should not be allowed in RMZs;
- Limit mineral soil exposure in RMZs to less than 5%;
- Within the RMZ, designate a zero-disturbance "riparian buffer" right beside the water body. The width should be about the same as an average tree in the area;
- Harvesting in the riparian buffer should be limited to removing dead and dying trees. These trees may topple, uproot, and cause erosion if left standing;
- Do not fell trees into the water body. Remove any slash that falls in it;
- Leave understorey vegetation and soil undisturbed in the riparian buffer;
- Never skid through a riparian buffer, up a streambank, or across a stream; and
- Refuel and do maintenance as least 100 m from the high water mark.

General Harvesting Guidelines for Agro-woodlots (Manitoba Conservation 2005b)

Guidelines most applicable to woody forest biomass are:

- Remove all merchantable timber. Cutting operations should take place in an orderly manner. Fire-killed and/or dead timber should be left as snags where possible;
- In cutblocks, cut and spread logging debris and brush over the cutover. Large brush piles on landings should be burned, depending on season and soils. Debris should not be pushed up against standing timber. Small debris piles may be left within the cutover for wildlife habitat;
- Attempt to follow Harvesting for Wildlife Guidelines;
- Be respectful of riparian and naturally unique or sensitive areas, by leaving the widest undisturbed buffer as possible; and
- Keep in mind that wrongful damage to the environment includes direct damage such as the destruction of young or merchantable timber, waste in cutting, unnecessary disturbance of the surface of the land (soil or vegetation), water damage, and road damage.

5.4.9 Protected areas legislation Under the *Forest Act*, logging is prohibited in provincial parks and under the *Ecological Reserves Act*, logging is prohibited in Ecological Reserves in Manitoba. Under the *Use of Wildlife Land Regulation of the Wildlife Act*, no logging is allowed in some Wildlife Management Areas.

5.5 Ontario

5.5.1 The forest biomass resource In 2009, 9.7 million m^3 of wood on 123 965 hectares was harvested in Ontario, which is about one-fifth of the volume that was logged in British Columbia (Natural Resources Canada 2011b). Ontario is estimated to have about one-third the roadside biomass as British Columbia. Ontario uses full-tree harvest methods, resulting in 90% of harvest residue being left at the roadside (Bradley 2010). The Annual Report 2008–09 Climate Change Action Plan (Province of Ontario 2009) stated that Ontario produces almost 50 million tonnes of biomass each year, which would produce enough energy to supply 7 million homes.

5.5.2 Land ownership Ninety-one percent of forest land in Ontario is publicly owned (8% private; 1% Federal). Policies related to private land are not discussed.

5.5.3 Status of forest biomass harvesting policy Policies to consider when planning for biomass removal in Ontario's Crown forests were summarized by Puddister et al. (2011).

The policy that addresses forest biomass harvesting in Ontario is the Ontario Forest Biofibre Policy (Ontario Ministry of Natural Resources 2008) released in March 2008 and set for review within 5 years. The policy defines forest biofibre as "forest resources from Crown forests that are not normally being utilized for conventional forest products and that are made available under an approved management plan. Forest resources as defined under the *Crown Forest Sustainability Act* (Statutes of Ontario 1994) are trees in a forest ecosystem, any other type of plant life prescribed by the regulations that is in a forest ecosystem, and parts of or residue from trees in a forest ecosystem." Available forest biofibre includes tree tops, cull trees, or portions of trees, unmerchantable and unmarketable trees and stands, and trees that may be salvaged as a result of a natural disturbance. The policy does not apply to residual by-products of mill operations such as such as wood shavings, sawdust, bark, or wood chips. The standards and guidelines for forest biomass harvesting are covered in Section 6.2 of the Stand and Site Guide (Ontario Ministry of Natural Resources 2010a). There are clearly defined restrictions on what can and cannot be removed through forest harvesting, regardless of the product derived:

- Stumps and all below-ground portions of a tree are not available for utilization as a forest product. Movement or removal associated with normal operations (construction of roads, landings, and skid trails, renewal, stand tending, slash piling, etc.), including incidental movement or removal during harvest operations, is permitted but must be minimized to that required for efficient operations. Removal for forest health purposes is permitted; and
- Organic matter that is not part of a harvested tree (including boles, branches, roots, bark, leaves, needles, debris, soil carbon, etc.) must remain on site. Movement of this material for access or silvicultural purposes is permitted.

Harvesting is restricted to areas where full-tree harvesting is an acceptable prescription according to silviculture guides, and may be done in previously harvested areas only where regeneration will not be damaged.

The Ontario Forest Biofibre Policy aims to provide the general direction for allocation and use of forest biofibre in Ontario Crown forests. The Ministry of Natural Resources (MNR) recognizes this as an environmentally friendlier alternative to oil and natural gas that can help meet Ontario's energy needs. The policy's goals are to "create and support new opportunities to develop and use new technologies and products in order to diversify the Ontario economy" and to "encourage the use of forest biofibre to reduce Ontario's dependence on fossil fuels and reduce energy costs through the development of bioenergy and biofuels projects." Objectives of the policy are to improve the utilization of forest products, to continue to identify opportunities that may benefit Aboriginal people, to evaluate the best end use for forest biofibre, to assure the MNR's commitment to sustainable forest management by ensuring that allocation of forest biomass is consistent with all existing policy, legislation, and approved management plans, and to develop and implement a pricing strategy.

Allocation, management, and sustainable use of forest biofibre must occur within the framework of established legislation and existing policy direction and associated regulated manuals and procedures. Any use of forest biofibre is regulated through the forest management planning process, and all regulations, standards, and standard operating procedures that apply to conventional wood harvesting must be followed (D. Morris, pers. comm., May 30, 2012). Forest management is guided and influenced by a large collection of national and provincial commitments, strategies, legislation and regulations, procedures, guidelines, codes of practice, standards, self-regulation, and negotiated formal or informal agreements. In this literature review, more documents of this sort were found for Ontario than for any other province or territory. Some involve legal requirements while others are not legally binding.

The right to use forest biomass is allocated through current sustainable forest licences but there has recently been a wood allocation competition where additional allocations specific to biomass have been given (D. Morris, pers. comm., May 30, 2012). Allocation decisions consider economic and employment opportunities and priority for allocation will be given to Aboriginal people and communities. The decisions consider how the use of the resource will contribute to the competitiveness and long-term viability of the forest industry and assist the forest sector to restructure and diversify. They also take into account how the use of the resource will contribute to meeting Ontario's renewable energy commitments. As for other forest resources, proponents wanting to use forest biofibre must have a Forest Resource Processing Facility Licence and provide a business plan for the facility. Crown charges will be at a level that provides incentive to develop new opportunities in the use of forest biofibre.

5.5.4 Existing forest biomass harvesting There is considerable interest in forest biomass harvesting in Ontario with the need to diversify the forest industry and the need to develop green energy sources both driving the industry (D. Morris, pers. comm., May 30, 2012). Ontario's *Green Energy Act* is contributing to development of the industry. As described above, only stands identified in existing forest management plans are utilized (i.e., small stands that would not be conventionally logged are excluded), and in those

stands any undesirable/unmerchantable trees can be taken, but green-tree retention guidelines still apply.

In Ontario, a number of companies are actively using forest biomass/roadside residues in their cogeneration facilities (Resolute Forest Products and Tembec) (D. Morris, pers. comm., May 30, 2012). The biomass is primarily used for heat and energy for the mills. Ontario Power Generation is nearing completion of the conversion of the Atikokan Generating Station from being fired by coal to biomass as wood pellets (D. Morris, pers. comm., May 30, 2012).

Readers are referred to Bradley (2010) for information on the recent (since 2007) attempts by the Ontario government to increase renewable energy production and the use of forest biomass for energy. In his 2008–2009 report, the Environmental Commissioner of Ontario cautioned to carefully assess the implications of increased use of biofibre on forest ecosystem resilience. Programs in 2007 and 2009 drew little interest, with a major barrier the inability of companies to obtain a secure wood supply from the Crown. Economics was another factor. In early 2009, the Ontario government began to streamline the process and announced a Request for Expressions of Interest to companies for innovative ideas on how to better use forest biofibre. The Expression of Interest call resulted in 130 applications for 143 facilities to use biofibre and 84 of these were to manufacture pellets. Ontario was expected to start signing wood supply agreements in late 2010 (Bradley 2010). In August 2010, the province issued the Ontario Power Authority a directive to negotiate a power purchase agreement for biomass electricity at the Atikokan Generating Station (see above).

5.5.5 Energy strategies, initiatives, and policies

Go Green, Ontario's Action Plan on Climate Change (Province of Ontario 2007)

This climate change action plan includes a commitment to reduce GHG emission to 6% below 1990 levels by 2020 and 15% by 2020 and affirms Ontario's interest in developing "green" energy sources.

Green Energy Act (Statutes of Ontario 2009)

This act builds on Ontario's progress towards phasing out coal-fired electricity and switching to renewable energy supplies. It is intended to foster the development of renewable energy with initiatives to attract new investment, create new green jobs, and protect the climate with assistance to industry, government, homeowners, and schools to transition to lower energy use. Renewable energy sources are defined to include wind, water, biomass, biogas, biofuel, solar, geothermal, and tidal. Key measures to facilitate development of renewable energy sources include the Feed-in-Tariff program that guarantees specific rates for energy generated from renewable sources, streamlined energy approvals, and mandatory connection and priority access.

Ontario's Long Term Energy Plan (Province of Ontario 2010)

This is an updated energy policy from the Ontario government that includes a target for the province for clean, renewable energy (wind, solar, and bioenergy) of 10700 MW by 2018.

Integrated Power System Plan (Ontario Power Authority 2007)

This 20-year plan aims to double renewable energy capacity from 2007 to 2027, including a goal to add 800 MW of biomass. The plan reflects Ontario's interest in the use of forest biomass as a renewable energy source.

5.5.6 Economic development strategies

Growth Plan for Northern Ontario (Ontario Ministry of Northern Development, Mines and Forestry and Ontario Ministry of Infrastructure 2011)

The Growth Plan aims to strengthen the economy in the north by: "diversifying the region's traditional resource-based industries, stimulating new investment and entrepreneurship, and nurturing new and emerging sectors with high growth potential." The plan indicates that efforts by the government, industry, and others should include identifying opportunities for developing the bioeconomy.

5.5.7 Policies/strategies related to sustainability The Ontario Forest Biofibre Policy (described earlier) aligns with Ontario's commitment to SFM, which considers more than just timber resources and logging, and involves planning for healthy ecosystems. Several strategies and policies, beginning in the 1990s, also reflect the move to SFM.

MNR: **Direction 90s** (Ontario Ministry of Natural Resources 1991) and **Direction 90s: Moving Ahead** (Ontario Ministry of Natural Resources 1995)

Goals and objectives for the Ministry are outlined, which are based on the concept of sustainable development, as expressed by the World Commission on Environment and Development.

Environmental Bill of Rights (EBR) (Statutes of Ontario 1993) and **Statement of Environmental Values** (SEV) (Ontario Ministry of Energy 2010)

The Environmental Bill of Rights is a legal document with purposes that include: (1) The prevention, reduction, and elimination of the use, generation, and release of pollutants that are an unreasonable threat to the integrity of the environment; (2) The protection and conservation of biological, ecological, and genetic diversity; (3) The protection and conservation of natural resources, including plant life, animal life, and ecological systems; (4) The encouragement of the wise management of our natural resources, including plant life, animal life, and ecological systems; and (5) The identification, protection, and conservation of ecologically sensitive areas or processes. Each of the ministries, including the MNR, that are subject to the EBR has a Statement of Environmental Values (SEV), which describes how the purposes of the EBR are to be considered whenever decisions are made in the Ministry that might significantly affect the environment.

Policy Framework for Sustainable Forests (Ontario Ministry of Natural Resources 1994)

This is the overall framework for forest management in Ontario, providing broad direction for forest policy and making forest sustainability the primary objective of forest management.

Crown Forest Sustainability Act (Statutes of Ontario 1994)

Sustained forest management became a legal requirement under this act.

Ontario Forest Accord (Ontario Ministry of Environment and Energy 1999)

The Ontario Forest Accord is an agreement by government, industry, and conservation groups to a mutually acceptable approach to the establishment of new parks and protected areas while also ensuring the security of the forest industry. The Accord included a commitment to streamline the forest management planning guides and regulations created under the *Crown Forest Sustainability Act*.

Beyond 2000 (Ontario Ministry of Natural Resources 2000b)

Beyond 2000 reaffirms the MNR mission of ecological sustainability, and sets out six supporting strategies for the ministry. It recognizes the importance of maintaining healthy and productive ecosystems across the province.

Forest Resource Assessment Policy (Ontario Ministry of Natural Resources 2003a)

This policy provides provincial direction for the preparation and use of assessments of Ontario's Crown forest resources. Locally, forest resource assessments are conducted during the preparation of forest management plans. Forest resource assessments are prepared every 5 years at regional and provincial levels to provide projections of both long-term forest health and long-term availability of Ontario's Crown forest resources.

Our Sustainable Future (Ontario Ministry of Natural Resources 2005)

The fundamental direction and priorities for the MNR are set out in this strategy. Goals include a strategy for a healthy natural environment, with efforts proposed to understand and mitigate impacts on biodiversity, adapt to climate change, and provide new endeavours in bioenergy. Another goal is economic development of natural resources.

5.5.8 Natural resource legislation

Crown Forest Sustainability Act (CFSA) (Statutes of Ontario 1994)

The CFSA is the main document regulating forestry activities on Crown lands in Ontario, outlining the legal requirements for forest management, including sustainability and management for all forest values.

5.5.9 Planning manuals (Ontario Ministry of Natural Resources 2000c, 2007b, 2009a,b) Under the CFSA, four manuals (the Forest Management Planning Manual, Forest Information Manual, Forest Operations and Silviculture Manual, and Scaling Manual) provide detailed direction on

various aspects of sustainable forest management. They were developed by the MNR in collaboration with non-government organizations and are based on the best available scientific knowledge, consultation with experts, and local monitoring data. There is a legally mandated review and revision every 5 years by resource managers from government and industry, as well as academics, researchers, consultants, and the public. As Puddister et al. (2011) point out, this review and revision process will allow for the addition of direction relevant to the developing bioeconomy. The Forest Management Planning Manual (2009) sets the requirements for Ontario's forest management planning system including planning, implementation, monitoring, and reporting. The Forest Information Manual (FIM) (2009) prescribes the mandatory (legal) requirements, standards, roles and responsibilities, timelines, and conditions for providing information in respect of Crown forests. The requirements for information prescribed in this manual compliment the planning and operational requirements of the Forest Management Planning Manual. Five FIM Technical Specifications (2009) supplement the FIM, outlining the detailed, technical conditions required. The Forest Operations and Silviculture Manual (2000) is compendium of guidance and direction for the conduct of operations authorized by approved forest management plans. It contains standards for forest operations and silviculture practices, minimum qualifications for persons who are engaged in forest operations, and assessment procedures and standards to be used in the evaluation of forest operations and forest management.

The Forest Operations and Silviculture Manual prohibits wasteful practices, stating: "Wasteful practices are defined in relation to the minimum utilization standards for the province. These standards have been designed to promote good forest management by ensuring optimum utilization of forest products on harvesting operations. Poor utilization of forest products may result in loss of revenue, lower productivity or higher regeneration costs or may cause inferior or undesirable trees to remain on the site. The minimum utilization standards must be followed on all forest operations unless otherwise described in an approved forest management plan. For example, merchantable trees and/or wood fibre may be left at a harvest site in order to satisfy silviculture and habitat requirements, or because of market-related issues associated with a certain species or product. Leaving merchantable trees at the harvest site because of market-related issues must not jeopardize the silviculture or habitat objectives of that harvest site. Reasons for leaving merchantable trees and/or wood fibre in specific areas within a forest must be described in the approved forest management plan. Failure to comply with minimum utilization standards unless otherwise described in the approved forest management plan is a wasteful practice. No person shall commit wasteful practices in forest operations."

The Scaling Manual (2007) provides standard instructions for determining the quantity, quality, and movement of Crown timber harvested in Ontario, as authorized under the *Crown Forest Sustainability Act*. Requirements in addition to those above are: "Where in the opinion of the Minister, sufficient markets exist for material smaller than that described . . . above, and only if agreed upon by the licensee in the approved Annual Work Schedule, the diameter outside the bark at the smaller end for merchantable timber may be reduced."

5.5.10 Guides

Forest Management Guide for Natural Disturbance Emulation (Ontario Ministry of Natural Resources 2001a)

The Forest Management Guide for Natural Disturbance Pattern Emulation (2001) provides management guidance (non-legal) for developing and implementing forest management plans so that managed forest landscapes will resemble landscapes created naturally by fire. Recommendations, which are quite detailed, are made for retention of residual patches, individual live trees, snags, CWD, and fine woody debris. Woody debris is recognized as being important for soils, wildlife, and regeneration, and, as for the other jurisdictions, a recommendation is to retain it where soils are shallow or coarse-textured. Other management guidance is:

Coarse and fine woody debris:

- The provision of downed woody debris is important to return nutrients to the soil, provide micro-sites for regeneration, and provide horizontal habitat structure for wildlife after harvest;
- Traditional logging provides less downed woody debris than does fire;
- Provide CWD through cut-to-length or tree-length harvesting systems, residual tree retention, leaving unmerchantable logs on site, and redistribution of roadside chipping waste material/slash (guideline);
- In manual cut and skid operations, leave cull material at the stump (guideline);
- Use cut-to-length, or tree-length harvesting techniques to leave slash on sites that are sensitive to nutrient loss (guideline);
- Avoid windrowing of CWD during site preparation operations (guideline);
- Fine woody debris is normally consumed by wildfires, releasing much of the nutritional content (e.g., nitrogen) to the atmosphere. However, nutritional elements such as potassium, magnesium, and calcium remain in significant quantities. For this reason, full-tree harvesting should be either discouraged on very shallow or very coarse-textured sites, or logging slash should be redistributed on the site after roadside delimbing or chipping (guideline); and
- Where roadside piles of delimbed slash cannot practically be returned to the cutover, piles should be burned since they provide little suitable habitat for wildlife. They also occupy prime tree-growing space along roadsides and should be burned to facilitate prompt regeneration (guideline).

Residual patch retention:

- Retain living internal patches, consisting of distinct "islands" greater than 0.25 ha on clearcut areas to provide vertical forest structure, relic patches of old growth, wildlife habitat, and future sources of downed woody debris. For similar reasons, also retain portions of live peninsular patches that are connected to the harvest block perimeter;

- Leave several patches rather than one big one;
- Distribute residual patches, individual trees, and snags so there are at least some individual trees retained on each hectare of the block;
- Leave 2–8% of the planned disturbance area in "islands" (the percentage depends on forest type) (guideline);
- Create patches well-distributed within the block, in a way that mimics fire (standard); and
- Patches are not available for subsequent harvest (standard).

Individual residual live trees:

- Leave trees should provide some semblance of the structure that would be left after a fire and provide a source of dead and down material in future (standard);
- Density and choice of individual leave trees depends on fire tolerance, silvicultural requirements, and wildlife habitat value (guideline) and the number of snags that could be left given the *Occupational Health and Safety Act;*
- Leave a minimum average of 25 well-spaced trees/ha of which at least six must be large-diameter, live, high-quality cavity trees or those with future potential to form cavities;
- Beyond the six live (future) cavity trees, a range of tree species and diameters (>10 cm in diameter and >3 m in height including unmerchantable and unmarketable species) should be left to maximize biodiversity;
- All 25 trees must be living only where snags could not be left for safety reasons; and
- Avoid leaving genetically inferior seed-bearing trees.

Snags:

- A large proportion of fires leave hundreds of dead trees (snags) per hectare standing on the site. Reproducing this structure is not economically viable;
- Based on economic constraints and limited biological data, leave a minimum of six large, living potential cavity trees (as above) and 19 others (in order of preference: snags, dying trees, and living trees of varying species and sizes >10 cm in diameter and >3 m in height) on all sites (standard). Vary the spacing moderately as required for diversity and machine maneuverability; and
- If needed create "snags" during mechanical harvesting.

Forest Management Guidelines for the Protection of the Physical Environment (Archibald et al. 1997)

This guidebook from 1997 provides Best Management Practices for preventing or minimizing damage to the physical environment when logging or doing other forestry activities on sensitive sites. The guidebook presents options to resource managers but the guidelines are not to be considered the only possibilities. Local conditions and circumstances may dictate the use of other treatments. Sensitive sites are defined as those with a high probability of damage occurring if managed according to standard operating practices. Site damage fact sheets are presented in

the guidebooks for five potential impacts on the physical environment: compacting and rutting, erosion, nutrient loss, loss of productive land, and hydrological impacts. Each fact sheet describes the type and impacts of damage, and the site factors, environmental conditions, and management activities that are associated with increased risk of damage. Planning, field layout, implementation, and monitoring practices to prevent, minimize, or mitigate negative impacts are described. Site damage hazard tables are included for compaction and rutting, erosion, and nutrient loss. The hazard is rated as low, moderate, or high depending on broad soil and site conditions. The following are some of the BMPs directly relevant to woody forest debris harvesting for operations on sensitive sites:

Compaction and rutting:

- In clearcuts, concentrate skidder traffic on main trails and locate them on areas with the highest load-bearing capacity. Slash mats will greatly increase the bearing capacity of the soil;
- Cut-to-length systems that limb and top at the site should place the slash in front of the machine on sites susceptible to compaction and rutting;
- Use high-flotation equipment in organic soils and closely monitor damage levels. Avoid harvesting operations on strongly decomposed mesic or humic peats during frost-free periods. For sensitive wet swale areas, avoid them completely, winch out of them, or reach in. Use limbs and tops to increase the load-bearing capacity of the soil;
- Minimize disturbance/removal of soil organic layers—they increase the soil's resistance to compaction and rutting. On fine-textured soils maintaining organic layers will prevent damage to soil structure by puddling;
- Allow or discontinue operations depending on the actual compaction and rutting that is occurring. In late winter or early spring it may be possible to operate at night and until the ground warms up in the morning. Shut-down may be required for a few days after heavy precipitation;
- Try to locate landings on non-productive areas such as rock outcrops; and
- Plan properly and make sure that operators are well trained and aware of objectives and plans for specific sites.

Erosion:

- Carefully adhere to BMPs for Compaction and Rutting where slopes are greater than 10%;
- Follow mandatory standards and good practices in Environmental Guidelines for Access Roads and Water Crossings;
- Apply the Timber Management Guidelines for the Protection of Fish Habitat as a minimum in riparian areas;
- Try to avoid locating haul roads and skid trails on steep slopes. Where possible, winch wood off slopes greater than 30% or reach in and place piles at the bottom or top of the slope rather than skidding or forwarding it;

- Consider extremely steep areas as inoperable;
- On high-risk sites consider operating only in winter; and
- On shallow soils retain some trees adjacent to precipitous slopes. Avoid harvesting areas that will clearly erode if trees are removed (i.e., areas with only a discontinuous layer of organic material over bedrock).

Nutrient loss:

- Sites sensitive to nutrient loss due to forest management practices include:
  - Extremely shallow soils (e.g., a discontinuous mat of organic material and/or less than 5 cm of mineral soil);
  - Very coarse-textured soils; and
  - Soils with little or no accumulated or incorporated organic material. (e.g., sites where extreme or severe wildfires have occurred).
- On poor sites, maximize the amount of slash left on the site. Nutrient losses from full-tree harvesting are more significant than from tree-length or cut-to-length operations since a substantial proportion of the nutrient reserves in a tree are in the foliage and branches;
- Bark, needles, and leaves chipped at the roadside should be respread on the block;
- Log in winter on shallow soils susceptible to nutrient losses; and
- Try to maintain some trees and plants on the block as a nutrient sink to capture mobile nutrient ions made available during harvesting.

Loss of productive land:

- Locate landings on non-productive soil (e.g., bedrock) where possible;
- Pile roadside wood as high as safely possible;
- Minimize inventories (i.e., storage) of wood in the bush. This uses less landing space;
- Choose equipment that can maximize the distance between roads;
- Use cut-to-length or tree-length lopping systems to minimize the size of slash piles at landings;
- Burn slash piles and redistribute piles of chips;
- Avoid techniques that pile slash in unproductive piles or windrows on the block unless they will be burned; and
- Soil contamination with fuel and oil is completely unacceptable.

Hydrological impacts:

- On very dry sites, the retention of some trees, shrubs, or even slash can lower ground temperatures and therefore reduce excessive drying; and
- Adhere to BMPs for Compaction and Rutting to lessen changes to water infiltration rates and lateral movement of water through the soil.

Forest Management Guide for Great Lakes–St. Lawrence Forest Landscapes (Landscape Guide) (Ontario Ministry of Natural Resources 2010b)

The Landscape Guide has the objective of directing forest management activities to maintain or enhance natural landscape structure, composition, and patterns that provide for the long-term health of forest ecosystems in an efficient and effective manner. This guidebook provides standards, guidelines, and BMPs for the landscape level. Landscapes are considered to cover tens of thousands to hundreds of thousands of square kilometres. The guidebook aligns with the two CFSA principles that direct Ontario's forest management planning. The first principle mandates that large, healthy, diverse, and productive Crown forests and their associated ecological processes and biological diversity should be conserved. The second principle is that conservation should be achieved through emulation of natural disturbances and landscape patterns while minimizing adverse effects on forest values. In order for forest biomass harvesting to fit into these principles, knowledge is needed of the amount of debris present in natural ecosystems.

The Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales (Stand and Site Guide) (Ontario Ministry of Natural Resources 2010a)

The Stand and Site Guide provides planners and operational people with direction on various aspects of biodiversity to help plan and carry out forestry operations on Crown forests. The guide includes the standard that "unless otherwise specified, the direction in this and other forest management guides applies equally to all planned harvest areas regardless of the product derived." Forest biomass harvesting methods fall under the direction of the guide (D. Morris, pers. comm., May 30, 2012). The guide addresses aquatic and wetland habitats and shoreline forests, special habitat features (e.g., bird nests, dens, bat hibernacula), and habitat for species at risk. It also provides guidance for topics such as road and water crossing construction and maintenance, soil and water conservation (e.g., rutting, erosion, nutrient loss), and salvage, and even biofibre harvest operations (unlike most other guides). The Stand and Site Guide replaces existing stand- and site-scale direction in the Natural Disturbance Pattern Emulation Guide, the Moose Guide, the White-tailed Deer Guide, the Pileated Woodpecker Guide, the Marten Guide, the Fish Habitat Guide, the Riparian Code of Practice, the Bald Eagle Guide, the Golden Eagle Guide, the Forest Raptors Guide, the Osprey Guide, the Heronry Guide, the Peregrine Falcon Guide, the Furbearer Guide, the Bat Guide, the Wetland Birds Guide, the Waterfowl Guide, the Cavity Nesting Bird Guide, the Warbler Guide, the Nesting Accipiters, Buteos and Eagles Guide, the Physical Environment Guide, and the habitat management direction in the Great Lakes–St. Lawrence Conifer Silviculture Guide and the Tolerant Hardwood Silviculture Guide. In this guide, standards must be followed as written. There is no room for interpretation on the part of forest managers. Guidelines are also mandatory and must be followed, but require professional expertise and local knowledge in order to be implemented. They may be a range of values, and implementing them may vary with site conditions or circumstances.

Best Management Practices are not mandatory rules, but are examples of practices that forest managers may wish to use.

Specific standards and guidelines for forest biomass harvesting in Ontario are in covered in Section 6.2 of the Stand and Site Guide (Biofibre Harvest) and were described earlier.

The Stand and Site Guide includes a long list of suggested strategies and techniques to minimize site disturbance during harvest, reforestation, and tending operations, including measures to reduce rutting and compaction, erosion, and soil nutrient loss. Major recommendations that pertain to woody forest debris harvesting are listed here; more detail is found in the guide.

1. Strategies and techniques to lessen soil nutrient losses

- Give preference to logging methods that leave debris and unutilized fibre in the cut area (e.g., cut-to-length, tree length) over logging methods that process and pile debris and unutilized fibre at the roadside (e.g., full tree);
- Where possible, re-distribute unutilized slash and chipper waste back over the cut area in a manner that will not interfere with silviculture or diversity objectives; and
- For standards and guidelines refer to silviculture guides.

Best Management Practices

- Identify sites susceptible to nutrient loss; and
- The guidebook appendix lists techniques and strategies to minimize nutrient loss.

2. Loss of productive land

Standards

- None

Guidelines

- Minimize the amount of area being converted to non-forest (e.g., roads and landings) to that required for efficient operations; and
- Unutilized woody material, which accumulates at roadside, is smothering productive land, and is expected to remain unutilized. Pile, redistribute, or otherwise treat this material to increase the area available for regeneration.

Best Management Practices

- As a rule of thumb, strive to keep the area of roads and landings to less than 4% of cutblock;
- Avoid piling unutilized fibre on productive non-forest cover types (e.g., brush and alder);
- Area converted to non-forest or non-productive forest (slash/debris piles, operational roads, landings, flooding, etc.) should be quantified and monitored for recovery into productive land; and
- Refer to Appendix for a partial list of strategies and techniques that may be used to minimize loss of productive land during operations.

3. Rutting and compaction

A rut is defined as a continuous trench or furrow created by machine traffic that is ≥ 4 m long and ≥ 30 cm deep. On shallow soils the lesser of depth to bedrock/large boulders or 30 cm is used.

Standards

- No more than 50% of any 0.1-ha circle is permitted in ruts. This is a unique type of requirement in Canadian forest soil disturbance guidelines;
- No ruts are permitted that channel water into, or within 15 m of, lakes, ponds, rivers, streams, woodland pools, or those portions of mapped non-forested wetlands dominated by open water or non-woody vegetation; and
- Clearcuts: Shallow soils (< 30cm): no more than 5% of any 20-ha area (or the operating block if less than 20 ha) is permitted in ruts. All other soils: no more than 10% of any 20-ha area (or the operating block if less than 20 ha) is permitted in ruts.

Guidelines

- Minimize the area of rutting and compaction; and
- In clearcut operations, where advanced regeneration is a significant contributor to future forest development, minimize the area in extraction trails. On sites susceptible to rutting, achievement of this guideline must be balanced against the increased rutting that may occur when extraction is concentrated on fewer trails.

Best Management Practices

- Field staff, particularly equipment operators, should be trained in the identification of sites susceptible to rutting and compaction;
- Identify susceptible sites in advance of operations (can use Site Disturbance Sensitivity Table);
- Develop local standard operating procedures; and
- See Appendix of the guidebook for a detailed list of strategies and techniques to meet the standards and guidelines.

4. Erosion

Standards

- No specific standards (refer to direction for roads and water crossings, rutting and compaction, and aquatic and wetland ecosystems).

Guidelines

- Decommission main skid trails constructed on steep slopes by installing water bars, diversion ditches, straw bales, etc. at appropriate intervals or critical landform junctures to filter runoff water through surrounding vegetation;
- Minimize mineral soil exposure to that required for efficient operations and effective silviculture; and
- Mitigate or rehabilitate areas of significant erosion that are transporting, or are likely to transport, sediment into a water feature.

Best Management Practices

- Identify susceptible sites;
- Develop standard operating procedures;

- Communicate the nature and location of susceptible sites to supervisors and equipment operators;
- Train staff (especially equipment operators) in recognition and significance of soil exposure and erosion;
- Areas susceptible to mass wasting (e.g., river banks, soil over steep bedrock) should be treated carefully. Site-specific rules and plans should be developed and should include specific measures to minimize erosion potential; and
- Rehabilitate areas where soil has been deposited on the roots of residual trees and an impact on productivity is likely.

5. Hydrological impacts

Standards

- None.

Guidelines

- Look for alternatives to working on organic and saturated mineral soils during the frost-free period; and
- Based on local conditions, take reasonable precautions to ensure that harvest, renewal, and tending operations will not result in disturbance of the forest floor that impedes, accelerates, or diverts water movement within recognizable ephemeral streams, springs, seeps, and other areas of groundwater discharge connecting to lakes, ponds, rivers, or streams.

Best Management Practices

- Train field staff, especially equipment operators, in the recognition and significance of disruption of hydrological function;
- Use hydrological modelling tools to help identify possible unmapped drainages, localized wet areas, misplaced or nonexistent but mapped drainages, and hydrological linkages (i.e., ephemeral streams, springs, seeps, other areas of groundwater discharge). Communicate the location and importance of these features to supervisors and operators before commencing operations in the local area;
- Avoid building roads or skidding through areas of accumulated flow, particularly when near a water feature;
- Where possible, locate roads and landings so skidding and forwarding does not have to cross natural drainage patterns;
- On very dry sites, careful logging practices that retain some trees, shrubs, advanced growth, and slash can reduce overall ground temperature and reduce excess drying; and
- Refer to Appendix for a partial list of strategies and techniques that will minimize site disturbance (e.g., rutting) during operations, and thereby minimize the risk of hydrological disruption.

6. Downed woody material:

Standards

- Stems retained as wildlife trees that fall down, or are felled for worker safety reasons, become downed woody material and, except in extraordinary circumstances, should be left on the site. Moving them for silvicultural purposes is permitted.

Guidelines

- Leave downed trees (or pieces of trees) present prior to harvest on the site (moving such trees for silvicultural purposes is permitted); where windstorms or other natural events (e.g., snow, ice) have recently caused damage to stands, trees leaning and downed by the recent disturbance, which normally would have been available for harvest, may be harvested and utilized.

Best Management Practices

- During all stages of forest operations, consideration should be given to the potential effects of operational prescriptions on downed woody material left on site. Mitigative measures should be used to:
  - Minimize the crushing of large, downed logs;
  - Minimize the smothering of coarse woody material by fine woody material or soil;
  - Minimize the windrowing of downed woody material. Where long windrows do occur, breaks should be provided to allow animals, other forest users, and operations unobstructed access routes. A 10-m break for every 100 m of windrow is a good target;
  - Piles of woody material not forecast to be utilized can be burned;
  - Where compatible with logging methods, unmerchantable logs, or portions of logs, should be left on site, at the stump; and
  - Dead trees present prior to harvest, including those lowered to the ground for safety considerations, should be left on site (only safe dead trees will remain standing).

7. Wildlife-tree retention in clearcuts

Standards

- Retain an average of ≥ 25 stems/ha;
- Retain an average of ≥ 10 large stems or large stubs/ha with a minimum of five large living trees on each hectare; and
- Except in extraordinary circumstances, wildlife trees that fall to the ground, or are purposely felled for worker safety reasons, become downed woody material.

Guidelines

- Create a mix of living cavity trees, stubs, supercanopy trees, veteran trees, mast trees, diversity trees, and safe dead trees as the large wildlife trees. The appropriate mix of large wildlife trees will be identified in the forest management plan and will be consistent with objectives established for the planning unit or area;
- When the number of large wildlife trees averages < 25 /ha, additional wildlife tree requirements may be met by retaining small safe standing dead trees, small stubs, or any other living trees;
- Disperse wildlife trees. Retain an average of at least 15 individual stems/ha; the remaining stems may occur in clumps; and
- Make reasonable efforts to avoid knocking down standing wildlife trees during renewal and tending treatments.

Best Management Practices

- "Stub" some wildlife trees (all tree species can be stubbed, but in boreal forests, the preferred species are jack pine and black spruce): (1) to a height of ≥ 3 m (5 m is preferred); (2) generally, do not stub existing cavity trees (however, it is acceptable to stub a tree with cavities below the stubbing height); (3) do not stub trees being relied upon as a seed source; and (4) do not stub wildlife trees if they are better suited for other wildlife tree functions (e.g., mast trees; fire-resistant species such as white pine, red pine, and hemlock are generally more appropriate to help achieve veteran and supercanopy direction);
- In areas that are predominantly stands of jack pine and/or black spruce, stub ≥ 20 jack pine or black spruce per hectare;
- When stubbing, try to have stubs scattered throughout the clearcut;
- Each planning unit or area (e.g., management unit, LLP) should identify which species are best suited for retention to achieve the large tree targets. Generally, trembling aspen, white pine, red pine, and white spruce are preferred species; white birch is also a suitable component of the wildlife tree mix;
- Where they occur, oaks and hemlock are also good wildlife tree choices;
- Diversity trees of any size are usually a good choice for retention;
- When large wildlife trees are specified, stems ≥ 38 cm dbh are preferred;
- Large hollow trees and those providing existing nesting or denning sites are preferred as cavity trees; and
- See also the Ontario Tree Marking Guide for detail on a recommended attributes of leave trees (much too detailed to list here).

Forest Management Guidelines for the Provision of Marten Habitat (Watt et al. 1996)

Forest Management Guidelines for the Provision of Marten Habitat (1996) contain recommendations mandatory for forest management in Ontario's boreal forests. Those directly related to forest biomass harvesting are:

- Silvicultural practices that retain logs, stumps, and other CWD on site are encouraged. The role of CWD in almost all aspects of marten ecology warrants special consideration of this element in management practices. Harvesting systems that leave slash at the stump, rather than at the roadside, and site preparation techniques that minimize slash removal and alignment, are the preferred option; and
- Harvesting methods should be modified within the bounds of the *Occupational Health and Safety Act*, to retain at least six dead or declining trees per hectare, with at least two of those exceeding 30 cm dbh.

Management Guidelines for Forestry and Resource-based Tourism (Ontario Ministry of Natural Resources 2001b)

Management Guidelines for Forestry and Resource-based Tourism are used in planning forestry activities where both forestry and tourism are

taking place, and, along with other planning manuals and guidelines, must be consulted in the development of forest management plans. Forest biomass harvesting is assumed to have to comply with these guidelines. The guidebook describes practices, tools, and techniques, based on operational experience, that should be considered when developing forest management prescriptions to protect resource-based tourism values.

Forest Management Guide for Cultural Heritage Values (Ontario Ministry of Natural Resources 2007c)

The Forest Management Guide for Cultural Heritage Values gives an overview of what cultural heritage values are, their importance to society, and how they can be protected from potential impacts from forest management operations. The guide breaks cultural heritage values into five classes: archaeological sites, archaeological potential areas, cultural heritage landscapes, historical Aboriginal values, and cemeteries. It was primarily written for planning teams to use when preparing and implementing forest management plans. As previously described, the *Environmental Assessment Act* (Statutes of Ontario 1975) and the *Crown Forest Sustainability Act* are the primary statutes that provide the legislative framework for forest management on Crown lands in Ontario. The *Environmental Assessment Act* defines the environment to include, among other things, the "cultural conditions that influence the life of humans or a community, any building, structure, machine or other device or thing made by humans . . . or any . . . interrelationships between . . . them." This act also has, as its purpose, "the betterment of the people of the whole or any part of Ontario by providing for the protection, conservation and wise management in Ontario of the environment." During the development of Forest Management Guide for Cultural Heritage Values, the Ministry considered a number of documents including MNR: Direction 90s (1991) and Direction 90s: Moving Ahead (1995), Beyond 2000 (2000), and Our Sustainable Future and the Statement of Environmental Values, which were mentioned earlier. This guide is intended to reflect the directions set out in those documents and to further the objectives of managing Ontario's resources on a sustainable basis.

5.5.11 Silviculture guides There are five silviculture guidebooks for Ontario, each for a different forest type, that identify sustainable silviculture approaches to achieve desired future forest conditions. They provide forest managers with guidance so that they can choose ecologically sustainable silvicultural practices when developing forest management plans, but they are not meant as rulebooks. The guides describe ecology of the forest types and both practices that are mandated (by policy or law) and those that are considered to represent best practices based on current knowledge and experience. In some cases lack of knowledge or variability in site and stand conditions precludes specific recommendations. As described in the Forest Biofibre–Allocation and Use directive, forest biomass harvesting may only be done on areas with approved forest management plans, so following these guides is hoped to ensure sustainability of the forest ecosystems and processes.

Silviculture Guide for the Great Lakes–St. Lawrence Conifer Forest in Ontario (Ontario Ministry of Natural Resources 1998b) and **Silvicultural Guide for the Tolerant Hardwood Forest in Ontario** (Ontario Ministry of Natural Resources 1998a)

The long-term impact of forest management on the supply of DWD is described as being uncertain for these forest types. The guides provide guidelines for retention of downed woody material on logged blocks:

- Operators should be encouraged to leave unmerchantable portions of tree boles at harvest sites to provide large-diameter DWD (bigger is better);
- Where silvicultural objectives and health and safety concerns will not be compromised, consider girdling or felling and leaving unmerchantable stems;
- Where feasible, use site preparation equipment and techniques that do not windrow or crush DWD; and
- Consider pre-harvest prescribed burns or burn when the water content of DWD is high.

Silvicultural Guide to Managing for Black Spruce, Jack Pine and Aspen on Boreal Ecosites in Ontario (Ontario Ministry of Natural Resources 1997)

This guide provides management interpretations that relate to biomass harvesting, including ecosites where biomass and nutrient removal should be limited and where full-tree harvesting is not or is conditionally recommended. One trend is that these restrictions apply on sites with dry, very shallow soils (< 20 cm mineral soil plus organic layer) (as for other jurisdictions). Also included in the guide are ecological interpretations for the ecosites, including tables showing habitat preferences of selected species, including downed woody debris and snags. The amount of CWD in immature, mature, and overmature forests is tabulated by ecosite, which is useful information when managing post-harvest woody debris in a way that mimics nature.

Silvicultural Guide to Managing Southern Ontario Forests (Ontario Ministry of Natural Resources 2000a)

Some reference to woody debris is made:

- Although it may be difficult to incorporate a target for downed woody debris (DWD) in tree marking prescriptions, leaving a target number of snags should over time increase the amount of DWD. Leaving defective portions of logs in the bush instead of dragging them to the landing and using careful logging practices that minimize disturbance to the forest floor could also increase the amount of DWD;
- For upland-tolerant hardwood types it is recommended to leave 2.3 m^3/ha of large cull or standing snag trees; and
- Long-butting of cull logs should occur at the stump to enhance the supply of downed woody debris.

Best Management Practices for management of woody debris include:

- Limb and top trees where they fall, keeping slash height below 0.6–1.2 m throughout the harvested area. This improves post-harvest

aesthetics, facilitates future access, and minimizes the amount of wood waste on the landings;

- Snags that must be felled should be left on site. These dead trees will provide a regular supply of woody debris to the forest floor and create habitat for more than 30% of all terrestrial vertebrates in southern Ontario forests;
- When limbing trees at the stump, leave large, hollow, or unmerchantable logs for wildlife rather than cutting them as blocks at the landing. Logs that are most effective for wildlife are longer than 2 m and wider than 60 cm in diameter;
- Cut stumps of leaning and damaged trees in the understorey low to the ground. This encourages sprouting on some species such as red oak and basswood, helping to regenerate the forest; and
- In regions where deer browsing severely disrupts natural regeneration, tops may be left uncut to protect new seedlings.

Some Best Management Practices to minimize damage to soils are:

- Preferably harvest when the ground is frozen or dry;
- Avoid harvesting during wet weather, and, in particular, during the spring break-up period (i.e., March to May) to minimize soil rutting, compaction, and erosion. These problems are difficult to fix; and
- Do not skid during and immediately following a heavy rain.

Acceptable minimum standards to strive for during harvest operations include that no more than 10–15% of the ground should be disturbed by harvesting.

Silviculture Guide to Managing Spruce, Fir, Birch, and Aspen Mixedwoods in Ontario's Boreal Forest (Ontario Ministry of Natural Resources 2003b) states that nutrients may be lost from a site as a result of some forestry operations, particularly full-tree logging, and especially where a large number of deciduous hardwood trees with nutrient-rich litter, such as aspen and birch, are removed. However, because the rich soils characteristic of boreal mixedwood sites have large nutrient stores, such nutrient loss may be of little overall concern, at least in the short term (Ontario Ministry of Natural Resources 2003b). Regardless, full-tree logging is not recommended for any harvesting or thinning treatments that leave a partial overstorey or when protection of advance growth is required. In these cases, the risk of unacceptable levels of damage to residual stems will be high. All logging methods may result in damage to residuals; 10 – 20% of stems damaged are not uncommon for full-tree logging (Ontario Ministry of Natural Resources 2003b). Cut-to-length may result in damage as low as 2%. The guide recommends that silvicultural prescriptions include objectives relating to acceptable levels of harvesting damage.

Ecosystem classification

Ontario has an ecological land classification system, classifying land into ecozones, ecoregions, and ecodistricts, and down to the level of the equivalent of ecosites and ecoelements at the regional scale (B. Crins, pers. comm., May 11, 2012). Interpretations have been made for ecosystems, although they are generally not published in the guidebooks

themselves (P. Uhlig, pers. comm., May 15, 2012). Interpretations specific to woody debris are probably not included.

5.5.12 Protected areas legislation The *Provincial Park and Conservation Reserves Act* (Statutes of Ontario 2006) allows for Conservation Reserves and seven classes of parks (two of these are aquatic/waterway and one cultural); commercial timber harvest is prohibited in all of them, except for the purposes of forestry research or park management.

5.6 Quebec

5.6.1 The forest biomass resource Quebec forests make up 20% of Canada's forests and the dense forest zone covers 761 100 km^2. Fifty-five percent of the dense forest zone is considered productive forest (so-called commercial forests). In 2009, 148 569 ha of forest was harvested in Quebec (volume not available) (Natural Resources Canada 2011b), which is more area than in British Columbia. Quebec is estimated to have the second largest volume of roadside harvest residues in the country, although it is only about half that of British Columbia (Bradley 2010). Quebec uses cut-to-length harvesting methods in 40% of its operations so 60% of residues are left at the roadside (Bradley 2010).

5.6.2 Land ownership Eighty-nine percent of Quebec's forest land is Crown-owned (11% private) (Natural Resources Canada 2011b). Private woodlots account for about 20% of the wood supply (Québec Ministère Ressources naturelles et Faune 2010).

5.6.3 Status regarding forest biomass harvesting policy The information in this section was provided by Evelyne Thiffault (pers. comm., Apr. 17, 2012). Quebec does not have a province-wide policy, however biomass harvesting is regulated at the regional level. In 2015 new forest management regulations will be introduced that may include more specific requirements for forest biomass harvesting. Currently, policy relating to woody biomass harvesting is decided at the regional, rather than provincial, level. The regional guidelines are based on local concerns and are developed by a committee that includes different groups including Aboriginals. Ecological site classification is used to define harvesting levels, taking into consideration the protection of soil, water, and biodiversity, as well as regional ecosystem vulnerability and operational constraints. Across the province, there is no policy preventing whole-tree harvesting, which comprises about 50% of the logging in Quebec (Hessilink 2010). Regional guidelines specify those sites where it is forbidden to return to a site and harvest the biomass once logging is completed.

5.6.4 Existing forest biomass harvesting The woody biomass harvesting sector has been slow to develop in Quebec (E. Thiffault, pers. comm., Apr. 17, 2012). However, many small projects are being developed that should be operational in 2013. These projects have resulted from a program involving auctions of given amounts of biomass to replace heavy oil as a local heating supply in schools, arenas, and other small facilities. Proponents must describe their project, and bidding takes place in each region. Success in allocating projects has varied across regions. This and other biomass allocation programs that have been introduced are described below.

2007/2008 Call for Proposals

This summary is from Bradley (2010). In 2007, Hydro-Québec called for an initial 100 MW tender as part of a total of 700 MW of biomass-generated energy, but this was unsuccessful as inadequate time was provided for preparation of proposals. Only two cogen project proposals at pulp and paper mills were received. There were no incentives for small power. Another program for wood bioenergy was launched in 2008, allowing 17 regional economic development boards to examine bioenergy proposals and recommend 5-year wood allocation contracts.

The Forest Biomass Heating Assistance Program

The Forest Biomass Heating Assistance Program, started in 2009 under the Climate Change Action Plan, gave funding assistance for building managers to use residual forest biomass for their heating needs. This 3-year program was aimed at 4500 institutional buildings to convert from light oil to biomass. Residual forest biomass is defined as unused tree parts (e.g., branches, crowns) that can be recovered. The program's objective is the reduction of 200 000 tons of equivalent CO_2 over 10 years. Since the Forest Biomass Heating Assistance Program was introduced in October 2009, 26 financial assistance applications for feasibility studies or supply of residual forest biomass have been approved. Nearly $1 million has been committed to these projects.

Developing the Value of Forest Biomass–An Action Plan (Québec Ministère Ressources naturelles et Faune and Cote 2009)

This action plan is a consolidation of the numerous programs and initiatives by the Ministère des Ressources naturelles et Faune (MRNF) to encourage the startup and development of energy production from forest biomass. On March 31, 2011, under this plan, 24 forest biomass allocation agreements representing a total of 1 500 000 tons were signed with various clients. The basic goal of the action plan is to eliminate 1.1 million tons of GHG emissions annually by 2016 by replacing fossil fuel energy with renewable energy, specifically biofuels (Québec Ministère Développement Durable, Environnement, et Parcs 2011). Forest biomass is defined in the action plan as: "waste products that result from logging and forest management, and of inferior quality timber that is not suited for industrial use. This includes trunks, crowns, and branches left in the woods or alongside forest roads." Stumps and roots are excluded from the definition. The action plan indicates that certain conditions must be met if forest biomass is to be used as an energy source: forest biomass availability must be sustainable, precautions must be taken to protect fragile soils, regulations affecting airborne particulate emissions must be complied with, and the impact of harvesting woody biomass on forest ecosystems must be monitored. It also states that at least 30% of woody material must be left on the site during harvesting.

The five primary objectives and policy instruments of the action plan are summarized below:

1. Make the resource available (Forest Biomass Allocation Program for Public Lands)

   The Forest Biomass Allocation Program sets the rules for forest biomass allocation in public forests in Quebec. The objectives of the program are to create and support new economic development initiatives, reduce Quebec's dependence on fossil fuels, facilitate the implementation of forest management strategies, and promote regeneration of mixedwood and hardwood forests. Biomass allocation is carried out with a competitive bid system using set evaluation criteria for various regional projects. Requests for proposals include an estimate of the volume available by biomass type. The allocations will be based on the following criteria:

   - The project's long-term financial viability and promoter's ability/resources;
   - Environmental gains;
   - Forest biomass to come from private forests;
   - Economic spinoffs and connections to other wealth-generating projects;
   - Integration with logging activities;
   - Prices offered for forest biomass; and
   - Other criteria deemed relevant by the Minister.

   Selected projects will be carried out under Annual Management Permits allowing for harvests of forest biomass in amounts that will meet the project specifications. The memorandum of understanding between promoters and MRNF will either be 5 years or a fixed period of time less than 5 years. The harvesting of forest biomass will therefore be within a flexible framework adapted to specific regions (E. Thiffault, pers. comm., Apr. 17, 2002). In the longer term, requirements may be written into the *Forest Act* as with other forest resources.

2. Encourage the replacement of fossil fuels (Heavy Oil Consumption Reduction Program)

   In 2008 the Quebec government allocated $150 million over 3 years to convert heavy oil heating systems to woody biomass. The program is administered by the Agence de l'efficacité énergétique and financed by the Green Fund. Financial aid is available for studies and development of energy efficiency measures regarding heavy fuel oil or conversion to greener energy sources such as natural gas and forest biomass. Reduced energy consumption would increase Quebec's competitiveness, reduce greenhouse gas emissions, and be more sustainable than using heavy fuel oils. There are four parts to the program; Part B is to have machinery and equipment for heavy fuel oil converted so that it is suitable for forest biomass, excluding sawdust, shavings, and bark. The goal of the program is to reduce GHG emissions by 1 million tons per year by its completion date. It is estimated that forest biomass projects could contribute to 40% of the goal, which would require about 400 000 tons of forest biomass per year. To date, $95 million has been committed to finance 144 projects (2006–2012 Climate Change Action Plan Annual Report).

3. Support investment (Actions arising from Measure 15 of the 2006–2012 Quebec Action Plan on Climate Change) (APCC)
Measure 15 is to support programs for manure processing and for the energy valorization of agricultural, forest, and municipal biomass. Actions are being planned (Feb. 2009) to reduce GHG emissions by converting these kinds of biomass into energy, of which forest biomass will play an important role. The actions will help Quebec implement its 2006–2015 Energy Strategy, Using Energy to Build the Quebec of Tomorrow.

4. Support innovation (Program to Promote Energy Efficiency and Technoclimat Program)
The goal of the Program to Promote Energy Efficiency (PPEE) is to provide financing to promote the development of new energy efficiency and production technologies in various stages: research and development, experimentation, demonstration, measurement, pre-commercialization, valorization, transfer, and distribution. Projects that develop the value of forest biomass are eligible.

   The TechnoClimat Program arose out of APCC Measure 20, which is to implement a program to support technological research and innovation for the reduction and sequestration of GHGs. The program has $110 M from the Green Fund to finance demonstration projects for innovative technologies and processes that have good potential for reducing GHG emissions. Projects that use forest biomass energy and reduce GHG emissions qualify under this program.

5. Stimulate demand for forest biomass (Hydro-Québec Call for Tenders for Biomass Cogeneration and Forest Biomass Awareness Campaign)
In spring 2009 Hydro-Québec Distribution issued a call for tenders for purchasing one 125 MW block of electrical energy generated from biomass. The idea is to encourage heavy industry to use biomass (especially forestry) and to provide Hydro-Québec Distribution with a new renewable energy electricity source.

5.6.5 Energy strategies, initiatives, and policies

For a Green and Prosperous Quebec: A Development Strategy for Quebec's Environmental and Green Technology Industry (Québec Ministère Développement Durable, Environnement et Parcs 2008)

$37 million was provided to promote the growth of environmental and green technology companies by supporting investment projects of companies that specialize in the environment and green technology, contributing to setting up a venture capital fund of about $100 million, and raising the financial community's awareness of the environment and green technology sector in order to facilitate access to financing. Another $237.5 million was provided to support green technology development, including supporting industrial research, disseminating university research results, supporting technology refinement and demonstration projects, and improving environmental certification mechanisms and implementation of measures to facilitate execution of demonstration

project. Lesser amounts were provided for measures to capitalize on the local market, promote internationalization, and support sector mobilization.

The Quebec Energy Strategy 2006–2015: Using Energy to Build the Quebec of Tomorrow (Québec Ministère Resources naturelles et Faune 2006)

This strategy includes an assistance fund for new energy technologies and the promotion by government of renewable fuels, with the use of forest and agricultural biomass and urban waste given priority over grain corn. This is recognized as being technologically difficult but research will be supported to address this. A task force will be created to better identify potential sources of feedstock and identify the business model best suited to maximize the spin-offs from it.

Quebec and Climate Change, a Challenge for the Future, 2006–2012 (Province of Quebec 2008)

Measure 15 of the Climate Change Action Plan was an allocation of $124 million to support programs for manure processing and for the energy valorization of agricultural, forest, and municipal biomass. Measure 20 was intended to implement a $135 million program to support technological research and innovation for the reduction and sequestration of GHGs. Forest biomass was specifically mentioned.

5.6.6 Economic development strategies

Plan Nord (Province of Quebec 2011; no longer available)

Plan Nord was a 25-year economic development strategy launched by the Quebec government in May 2011 to develop natural resources in northern Quebec. One priority initiative for forests identified in the plan is to "support initiatives that allow the use of forest biomass by conducting studies, opportunity analyses and inventories and by seeking uses (energy, wood-derived products, and so on) and good practices."

5.6.7 Policies/strategies related to sustainability Quebec released 19 forest management documents related to soil and water conservation, biodiversity, and sustainable forest management between 2004 and 2008 (Natural Resources Canada 2012).

Sustainable Development Act (Statutes of Quebec 2006)

The *Sustainable Development Act* (2006), which is not specific to natural resources, has as its objective: "to establish a new management framework within the Administration to ensure that powers and responsibilities are exercised in the pursuit of sustainable development. The measures introduced by this act are intended, more specifically, to bring about the necessary change within society with respect to non-viable development methods by further integrating the pursuit of sustainable development into the policies, programs and actions of the Administration, at all levels and in all areas of intervention. They are designed to ensure that government actions in the area of sustainable development are coherent and to enhance the accountability of the Administration

in that area, in particular through the controls exercised by the Sustainable Development Commissioner under the *Auditor General Act* (RSQ, chapter V-5.01)."

The act sets clear legislation for sustainable development in Quebec, including: establishment of a definition of sustainable development for Quebec, setting of 16 principles to guide the actions of the public service, a commitment by the government to adopt a single sustainable development strategy applicable to all departments and a considerable number of agencies, assignment of the Premier to table the Government Sustainable Development Strategy in the National Assembly and report on its progress every 5 years, a commitment for departments and agencies concerned to identify actions they will take to help reach the strategy's governmental objectives and annually report results of their undertakings, and introduction of sustainable development evaluation and accountability mechanisms to measure progress. The act commits the government to adopt a system of sustainable development indicators, and appoints a Sustainable Development Commissioner reporting to the office of the Auditor General of Quebec to ensure the transparent evaluation of results.

Sustainable Development Strategy (Province of Quebec 2007)

The Sustainable Development Strategy 2008–2013, released in 2007, which again deals not just with forest resources, forms the basis for the framework of the government's sustainable development initiative, which calls for the participation of all government departments and agencies, as well as Quebec society. Under Direction 6, the Strategy calls for integrated land management at all decision-making levels, which includes preserving biodiversity and environmental protection. This Strategy implemented a key element of the *Sustainable Development Act*.

Sustainable Management in the Boreal Forest (Québec Ministère Ressources naturelles et Faune 2008)

In response to concerns of the Quebec population, Sustainable Management in the Boreal Forest was written to clearly illustrate Quebec's achievements in sustainable forest management in boreal forests by describing current actions and the progress that must be made if management is really sustainable. The document recognizes forest biomass, including branches, roots, and silvicultural waste, as an "excellent" resource for energy production, given rising energy prices and the need to reduce GHG emissions. The document describes measures defined by the MRNF that forest managers must include in their forest management plans, including leaving snags and living trees for future recruitment of woody debris. The MRNF requires that there are no extensively rutted areas in logged blocks, and that 90 percent of harvested areas are to exhibit little or no rutting.

5.6.8 Natural resource legislation

Forest Act (Statutes of Quebec 1996)

Quebec's *Forest Act* did not originally permit harvesting of forest biomass from Crown land until the Forest Biomass Allocation Program for Public

Lands (June 2008) made it possible. The Biomass Allocation Program was previously described.

The *Forest Act* requires a permit for any forestry activities: "No one may carry on a forest management activity other than road maintenance unless he is the holder of a forest management permit issued for that purpose by the Minister. Forest management includes timber felling and harvesting, installing, improving, maintaining and closing infrastructures, carrying out silvicultural treatments including reforestation and the use of fire, suppressing insect epidemics, cryptogrammic diseases and competing vegetation, and all other activities affecting the productivity of a forest area."

The *Forest Act* includes a commitment to promote sustainable forest development in order to meet the economic, environmental, and social needs of present and future generations while giving proper consideration to other potential uses of the territory. Sustainable forest development is defined as being conducive to: "the preservation of biological diversity; the maintenance and improvement of the condition and productivity of forest ecosystems; the conservation of soil and water resources; the maintenance of the function of forest ecosystems as a component of global ecological cycles; the maintenance of the multiple socioeconomic benefits society derives from forests; and the giving of proper consideration, in selecting forms of development, to the values and needs expressed by the populations concerned."

Regulation respecting standards of forest management for forests in the public domain (Statutes of Quebec, n.d.)

This regulation sets out very specific requirements for forest management activities. Some are more quantitative than for other jurisdictions. Ones that relate to forest biomass harvesting include, but are not limited to:

Utilization standards

- Stump heights can be no greater than 30 cm; exception applies if there is snow;
- Trees may be harvested only if their diameter is at least as large as that authorized in the management permit; and
- Volume of useable ligneous material (sound material up to the minimum required merchantable top diameter) may not exceed 3.5 m^3/ha on a block or 1 m^3/ha on an area used for piling, lopping, and sawing. If the volume is greater, the permit holder must recover it.

Soil disturbance

- The area occupied by felling and hauling trails must be < 33% of the block area; and
- Harvesting or felling of trees on soils with drainage class 5 or 6 is not permitted unless soils are frozen to a depth of at least 35 cm.

Riparian areas

- Buffers 20 m wide are required along the banks of a peat bog with a pond, a swamp, a marsh, a lake, or a permanent watercourse;

- Trees may be harvested in a buffer only if it has a slope of less than 40%;
- At least 500 live trees/ha, with a dbh of at least 10 cm, must be retained;
- The intensity of cutting must be the same as in the adjacent management areas, without reducing the basal area to less than 14 m^3/ha;
- Machinery may not be used in the buffer in a buffer strip 5 m on each side of an intermittent watercourse except for road construction, improvement, or maintenance, for digging drainage ditches for silvicultural purposes, or installing or maintaining infrastructures;
- Any parts of a tree that fall into a lake, a watercourse, or any fish habitat during forestry activities must be removed;
- Temporary bridges must be installed when trails are laid across watercourses or fish habitat; and
- Cleaning or washing machinery in or within 60 m of a lake, a watercourse, or a fish habitat is not permitted.

Terrestrial buffers are also required, for example:

- 60 m around existing or proposed ecological reserves;
- 60 m around bear dens in winter;
- 30 m around sanitary fills and burial sites;
- 60 m around historic sites and recreation sites; and
- 30 m on both sides of a highway corridor.

The regulation also specifies requirements for activities in specific wildlife habitats (e.g., caribou, deer, and birds).

5.6.9 Forest management plans The Forest Resource Protection and Development Objectives (Québec Ministère Ressources naturelles et Faune 2005) set out the protection and development objectives that apply to general forest management plans (GFMPs) in Quebec for the period 2007–2012. They are legal requirements. The objectives that relate to the environment include:

- The conservation of soil and water resources (reduce rutting, minimize losses of productive forest areas, protect aquatic habitats by avoiding sediment inputs); and
- The preservation of biological diversity, including preserving deadwood in managed forests.

The following measures related to deadwood were required to be implemented in the 2007–2012 GFMPs:

- All types of forestry work will be permanently prohibited in 20% of the total area of riparian strips to allow for the development of very old trees of different species, which will eventually become large snags and debris;
- Clusters of trees measuring some hundred square metres each must be left intact on certain sites subjected to cutting with protection of regeneration and soils (CPRS) to provide a constant supply of deadwood throughout the stand rotation period. This measure will apply to at least 5% of CPRS areas beginning in 2007;
- During logging operations, all snags and non-commercial living trees must be left standing, provided they do not compromise management objectives or worker safety; and

- In selection cutting areas, large dying trees (vigour class IV (M)) with a basal area of at least 1 m^2/ha must be left untouched.

5.6.10 Guides

Ecological Land Classification

In 2005, the MRNF made a commitment to promote the application of ecosystem-based management in Quebec's public forests, requiring that all forest stakeholders have a shared understanding of the concept of ecosystem-based forest management and its application. The Ecological Land Classification Hierarchy (Jurant et al. 1977) is Quebec's ecosystem classification system.

5.6.11 Protected areas legislation Under the *Parks Act* (Statutes of Quebec, n.d.), any "utilization, harvesting, or harnessing of resources related to logging" is prohibited in provincial parks in Quebec. These parks can be decreased or increased in size or abolished. Altogether, there are 22 designations of protected areas in Quebec, including Ecological Reserves, Wildlife Reserves, Biodiversity Reserves, and Exceptional Forest Ecosystems.

5.7 Nova Scotia

5.7.1 The forest biomass resource Nova Scotia logged about one-twelfth the volume of British Columbia in 2009 (about 4.2 million m^3 harvested on 41 346 hectares in 2009). Harvest residues at the roadside have been estimated at 5% of the amount in British Columbia (Bradley 2010).

5.7.2 Land ownership Unlike most Canadian jurisdictions, only 29% of Nova Scotia's forests are publicly owned (68% private; 3% Federal) (Natural Resources Canada 2011b1). Policies and guidelines discussed in this section are specific to provincial Crown land because information relating to private land was not obtained in time.

5.7.3 Status of forest biomass harvesting policy Forest harvesting practices in Nova Scotia are a contentious issue, subject to wide debate (Nova Scotia Department of Energy 2010). Nova Scotia developed some guidelines for forest biomass harvesting, but then did not put them in place because of a moratorium on using slash from Crown land for electrical production. Currently, biomass in Nova Scotia refers mostly to wood that is still in the round, and limbs and tree tops are left in the woods (T. Stalker, pers. comm., May 29, 2012). Biomass is trees that are unmerchantable either because they are a low-demand species such as poplar, or dead and rotten and unsuitable for pulp. Regulations are being prepared to clearly define if or how much of limbs and tree tops can be used.

In the Renewable Electricity Plan (Nova Scotia Department of Energy 2010) the government commits to a cautious approach regarding the use of forest biomass for electricity production because it identifies it as inefficient for the sole purpose of generating electricity through co-firing. Far more energy is extracted from biomass used to heat water or living spaces. The plan specifies that electricity produced from co-firing biomass will play a role in meeting a 2015 GHG emission reduction commitment but will undergo review for use past 2015. The Renewable Electricity Plan stipulated a number of rules for forest biomass harvesting operations for electricity including that

in order to qualify as a renewable energy source it must be harvested using sustainable practices. Fuel from harvesting and silviculture must come only from stem boles and fuel may not be harvested from coarse or fine woody debris, tree crowns, tops, or stumps unless it originates in a non-forestry operation such as agricultural land clearing, highway right-of-way clearing, or commercial or residential construction. There are requirements that the total regional harvest must be sustainable, the power producer must make maximum use of wood wastes from other manufacturing processes, must have forest certification, and must be a registered buyer under the *Forests Act*.

The Policy Framework for the Future of Nova Scotia's Forestry (Province of Nova Scotia 2010), announced in December 2010, laid out strategic directions that were to provide the basis for future forest policy, which is set out in The Path We Share, A Natural Resource Strategy for Nova Scotia 2010–2020 (Nova Scotia Department of Natural Resources 2011b), released in August 2011. Changes included restricting clearcutting to a maximum of 50% of harvesting, and changes to forest biomass harvesting guidelines (see below).

In The Path We Share, A Natural Resource Strategy for Nova Scotia 2010–2020 (Nova Scotia Department of Natural Resources 2011b) the government's cautious approach to forest biomass use is apparent. The steering committee advised the government to use great caution regarding the use of biomass for power generation, and urged them to explore and expand other sustainable methods of generating power. A companion to this document entitled From Strategy to Action, An Action Plan for the Path We Share, A Natural Resources Strategy for Nova Scotia (Nova Scotia Department of Natural Resources 2011a) was released at the same time and listed the actions the government planned to take. Actions to be taken over the following 6 months included clarifying the use of forest biomass to generate electricity and changing the Forest Sustainability Regulations (Statutes of Nova Scotia 2007b) under the *Forests Act* to make biomass users subject to the same rules as the existing forest industry, and establishing rules for whole-tree harvesting. Standards for removing forest biomass from sites were to be clearly identified in the Code of Forest Practice (Nova Scotia Department of Natural Resources 2008). Adding clear definitions and reporting requirements to policy was intended to ensure that the use of forest biomass and other primary forest fibre would be well monitored.

The Renewable Electricity Regulations (first set in 2007 under the *Electricity Act*) (Statutes of Nova Scotia 2010) had set a cap of 500 000 tonnes per year for consumption of woody biomass for renewable electricity, which was considered prudent, but even so was reduced in April 2011 to 350 000 tonnes/year after the Natural Resources Minister decided it was not conservative enough. In June 2011, the Renewable Electricity Regulations were refined to specify that forest biomass must not be a primary forest product and used first as fuel. The regulations required that any proposals for a primary forest biomass renewable low-impact electricity generation facility must provide a biomass fuel procurement plan outlining how the proponent would ensure that its fuel supply will meet sustainable harvesting requirements.

5.7.4 Existing forest biomass harvesting For decades, Nova Scotia used imported coal as its main energy source (80%), but increased costs and mine closures mean it is no longer a dependable, low-cost source of electricity

(Bradley 2010). Local jobs have suffered and it is becoming environmentally unacceptable, so attention has been turning to renewable energy, which creates local jobs and investments.

Woody biomass is used in Nova Scotia for firewood in more than 100 000 homes, a 22 MW biomass electrical co-generation facility in Brooklyn, a sawmill producing heat and power, pulp and paper plants, two pellet manufacturing plants, numerous greenhouse operations, sawmill lumber drying kilns, and wood-pellet industries that power their facilities with production waste. Institutional users include the Nova Scotia Agricultural College and South Shore and Annapolis Valley Regional Hospitals (Nova Scotia Department of Energy 2010).

The Nova Scotia Community Feed-In Tariff (COMFIT) program (Nova Scotia Department of Energy 2011), overseen by the Nova Scotia Department of Energy, is a new initiative designed for locally based renewable electricity projects that enables proponents to receive an established price per kilowatt hour for electricity produced from qualifying projects. Applications were first accepted in September 2011. To be eligible, the projects must be community-owned and connected at the distribution level (i.e., typically under 6 MW). Forest biomass projects require registry with the Department of Natural Resources Registry of Buyers, are subject to the same legislation as the forest industry, and are limited to stem-only wood from non-merchantable trees.

5.7.5 Energy strategies, initiatives, and policies

Renewable Energy Standards (Province of Nova Scotia 2007)

> Legal requirements are that by 2013, Nova Scotia will generate at least 18.5% of its electricity through renewable energy sources—wind, tidal, biomass, solar, and hydro. By 2015, Nova Scotia aims to generate 25% of its electricity with renewables and 40% by 2020.

Environmental Goals and Sustainable Prosperity Act (Statutes of Nova Scotia 2007a)

> This act includes the target of 10% less GHG emissions than 1990 levels by 2020.

Towards a Greener Future: Nova Scotia's Climate Change Action Plan (Nova Scotia Department of Energy 2009)

> The Climate Change Action Plan outlines 68 climate-change actions with two main goals: (1) to reduce the province's GHG emissions; and (2) to prepare for climate change. Nova Scotia has aimed to reduce GHG emissions by at least 10% from 1990 levels by 2020. The greatest single reduction was to be achieved by imposing caps on emissions from Nova Scotia Power Incorporated (NSPI), which produces 46% of the province's GHG emissions. The caps were to take effect in 2010, 2015, and 2020. The two most cost-effective means of reducing emissions from power generation in Nova Scotia were described as straightforward: generating less electricity and generating it from clean, renewable sources.
>
> Short-term measures of the Energy Strategy (see below) and Climate Change Action Plan included the 2013 Renewable Energy Standard (Province of Nova Scotia 2007), which will require NSPI to add new

renewable energy sources by the end of that same year. Mid-term actions included ensuring that at least 25% of Nova Scotia's electricity is generated from renewable energy sources by 2020. Two specific actions to be taken were: (1) in order to support the development of biomass for electrical generation, provide the forest industry with funds from the Community Development Trust to study the feasibility of potential biomass generation projects; and (2) to support development of other uses for forest biomass, provide funds from the Community Development Trust to improve understanding of forest biomass availability and the potential of forest biomass projects to improve site productivity.

Toward a Greener Future: Nova Scotia's 2009 Energy Strategy (Nova Scotia Department of Energy 2009)

A companion to the Climate Change Action Plan, this strategy set out the following policies and strategies: increase energy efficiency in the province by 20%, using less imported coal and more diverse sources of clean, local, and renewable energy, encourage more renewable electricity energy, encourage onshore and offshore exploration and development for petroleum, consult widely and seek advice on sustainable energy policy, support the participation of Nova Scotians in the energy industry, and keep Nova Scotia's energy markets open for imports and exports. The energy strategy identified biomass (wood, wood waste, fast-growing grasses and trees, and construction waste such as lumber) as an emerging option for energy, but indicated that biomass resources need evaluation for supply, sustainability, and cost, which were being studied by the Province, NSPI, and other stakeholders. Biomass was recognized as having the potential to displace coal and supply firm, predictable amounts of electricity. It was also considered an attractive economic opportunity to use Nova Scotia's fuel sources to lessen dependence on foreign coal. Nova Scotia Power proposed to meet some of the Renewable Energy Standard targets with biomass power from independent producers. Biomass could also be mixed with coal and used in existing plants.

Position Paper—Ecology Action Centre (Simpson 2008)

The position paper, Forest Harvesting for Energy: Recommendations for Nova Scotia makes 12 recommendations for forest woody biomass harvesting. This is neither legislation nor a government document. In May 2010, the Ecology Action Centre called for an immediate moratorium on burning forest biomass for electricity. Their points included:

- Whole-tree harvesting (removing the entire tree from the stump up) must not be used on the vast majority of harvesting sites on Crown lands. The Province should introduce similar regulations for private land;
- The Department of Natural Resources must assume a responsibility to provide educational material to landowners on the detrimental consequences of whole-tree harvesting;
- The Province must enforce regulations on wood-value optimization to ensure that high-value logs are not chipped;
- The Province must monitor Crown land to ensure that immature stands are not clearcut for biomass;

- The Province must enforce the Wildlife Habitat and Watercourse Protection Regulation to leave standing dead trees and as much as possible of the large woody debris on harvested sites;
- In addition to the above recommendation, the Province must set minimum, measurable, stand-level objectives for numbers of standing dead and dying trees. The best research to date recommends a minimum of eight snags and eight potential nest trees greater than 25 cm dbh per hectare. Minimum volumes of fallen deadwood (>10 cm diameter and 2 m length) should be approximately 110 m^3/ha in softwood stands, 40 m^3/ha in hardwood stands, and 60 m^3/ha in mixedwood stands. If minimum volumes of CWD are not present, harvesting must leave sufficient cut trees to meet the minimum levels;
- The Province must incorporate carbon budgeting in forest management planning on Crown land; harvesting and silviculture activities must not result in net loss of carbon from the forest. Carbon loss from the soil must be minimized at harvest sites;
- The Province should promote and assist bio-energy plants that (1) are co-generators (electricity and heat), (2) have appropriate technology to meet best practice air emissions standards, (3) are regionally dispersed, and (4) are tied to local production and consumption of energy;
- Prior to creating additional capacity or expanded supply of biomass, the Province should ensure maximum efficiency of existing wood product wastes by improving technology at pulp mills and other existing bio-energy producers;
- The Province must strive to ensure that plantations for bio-fuel be created only on under-utilized agricultural lands, and not at the expense of food production. Sewage sludge (bio-solids) could be considered as a fertilizer for such plantations, provided the sludge is free of heavy-metal contamination and other environmental pollutants;
- The Province must not provide subsidies or other incentives for biomass harvesting or biomass harvesting equipment; and
- The Province should restrict the export of raw biomass, including chips.

5.7.6 Policies/strategies related to sustainability/natural resources legislation The Department of Natural Resources in Nova Scotia has responsibility for a wide range of Crown resources, including timber and forests, wildlife and wildlife reserves, endangered species, fire and pest protection, Provincial Parks, beaches, and mineral resources. There are many acts, regulations, and policies guiding Nova Scotia's forest resources. The concept of sustainable forest management is embodied in several pieces of provincial legislation related to management of Nova Scotia's forests, including the *Crown Lands Act* (Statutes of Nova Scotia 1989a), revised *Forests Act* (Statutes of Nova Scotia 1989b), *Forest Enhancement Act* (Statutes of Nova Scotia 1989c), and Wildlife Habitat and Watercourses Protection Regulations (Statutes of Nova Scotia 2002), as well as the Code of Forest Practices (Nova Scotia Department of Natural Resources 2008). Other initiatives recommending a commitment to sustainable forestry management

were outlined in Towards Sustainable Forestry: A Position Paper (Nova Scotia Department of Natural Resources 1997) as well as national ones (described earlier). In addition, the concept of Integrated Resource Management (IRM) was incorporated into the planning process on Crown Lands in 2002 under the IRM Land Use Strategy. The Forest Sustainability Regulations (Statutes of Nova Scotia 2007b) apply to private woodlot owners (registered buyers who acquire more than 5 000 m^3 wood/yr must carry out a silviculture program or contribute money to a special fund, or a combination of the two).

Forests Act

The *Forests Act* states: "The principle of sustainable forest management forms the basis of all forest management programs in the Province." The purposes of the *Forests Act* include developing a "healthier, more productive forest capable of yielding increased volumes of high quality products" and "maintaining or enhancing wildlife and wildlife habitats, water quality, recreational opportunities and associated resources of the forest." The Minister has the job to "ensure that wildlife, wildlife habitats and the long term diversity and stability of the forest ecosystems, water supply watersheds and other significant resources are managed."

Wildlife Habitat and Watercourses Protection Regulations

The Wildlife Habitat and Watercourses Protection Regulations of the *Forests Act* sets out requirements for retention of standing trees, snags, and woody debris on logged sites:

- On any harvest site larger than 3 ha, the forestry operator shall ensure that at least 10 living, or partially living, trees are left standing on each logged hectare;
- The trees left standing shall: (1) be in the same proportion by species as the forest stand being cut; (2) have a diameter and height at least as large as the average height and diameter of the trees in the cut stand; and (3) be clumped together in this way (a) each clump shall contain no fewer than 30 trees, (b) there shall be at least one clump for each 8-ha cut, (c) where there is more than one clump, clumps shall be < 200 m apart and 20–200 m from the edge of the cut area, (d) where there is one clump, it shall be 20–200 from the edge of the cut area, and (e) trees within the clump cannot be removed before the next harvest; and
- A forestry operator shall ensure that levels of snags and CWD on all harvested sites are similar to natural patterns to the fullest extent possible.

These regulations also specify requirements for activities near watercourses:

- A 20-m buffer is required where the average width of a stream is greater or equal to 50 cm;
- No more than 40% of the merchantable timber may be harvested in one event and at least 20 m^2 of the basal area must be left standing;
- Vehicles for forestry operations must not operate within 7 m of a watercourse;
- Streams less than 50 cm wide can be harvested to the streambank as long as vehicles stay at least 5 m from the stream;

- Understorey vegetation and non-commercial trees within 20 m of the edge of any watercourse must be retained to the fullest extent possible; and
- No forestry operator shall conduct any activity within 20 m of the edge of any watercourse that would result in sediment being deposited in the watercourse.

Code of Forest Practices

Nova Scotia's Code of Forest Practices are mandatory guidelines for Crown land and encouraged for private land owners. The code follows the principles of sustainable ecosystem management, with the primary ecological goals including biodiversity conservation and ecosystem productivity and resilience. Some reference to forest biomass is made. Prescriptions for forest management treatments must consider downed CWD for wildlife habitat and site enrichment. Forest operations are recognized to have the potential to significantly alter site productivity and the Code indicates that some timber harvest systems can degrade a forest site through biomass removal. A requirement of the Code is that timber harvest and biomass removal from a site will remain below rates that would impair long-term site productivity. In December 2010 it was announced that it was prohibited to remove whole trees from the forest site in order to maintain woody debris, which Nova Scotia says is important for soil and biodiversity management, and is consistent with the province's Renewable Electricity Plan. Christmas-tree harvesting is exempt. The Code also requires that the amount of merchantable wood left on the harvest site will be minimized, excluding wood left to meet requirements for biodiversity and soil organic matter. The Code specifies that: "Management and harvest activities will strive to maximize wood product values from Nova Scotia's forests." The requirement therefore seems to be to maximize removal of merchantable wood but limit the removal of unmerchantable wood.

Crown Lands Act

The *Crown Lands Act* is another piece of legislation that has relevance to forestry operations in Nova Scotia. Its objectives are: to provide for the most effective utilization of Crown lands by:

- The application of proven forest management techniques to enhance productivity on Crown lands and to provide for an increasing harvest of better-quality forest products;
- Requiring that leasing and licensing arrangements on Crown lands are providing for equitable stumpage rates, adequate investments in forest improvements, and improved market access for privately produced wood;
- The integration of wildlife and outdoor recreation considerations in the forest management planning process on Crown lands; and
- The more effective administration and management of all Crown lands.

The act also specifies that, "the Minister shall manage wildlife and wildlife habitats on Crown lands and provide for the maintenance of long-term productivity, diversity and stability of the forest ecosystem"

and "no person shall cut or remove timber or other resources on or from Crown lands unless that person is expressly authorized to do so pursuant to this *Act* or the regulations." Clearly then, forest biomass could not be removed from Crown land without authorization.

Environmental Goals and Sustainable Prosperity Act (Statutes of Nova Scotia 2007a)

The *Environmental Goals and Sustainable Prosperity Act* is another act indicating that the environment is an important consideration in economic development, stating "The long-term environmental and economic objective of the Province is to fully integrate environmental sustainability and economic prosperity." The act is based on the following principles:

- "the health of the economy, the health of the environment, and the health of the people of the Province are interconnected;
- environmentally sustainable economic development that recognizes the economic value of the Province's environmental assets is essential to the long-term prosperity of the Province;
- the environment and the economy of the Province are a shared responsibility of all levels of government, the private sector and all people of the Province;
- the environment and economy must be managed for the benefit of present and future generations;
- innovative solutions are necessary to mutually reinforce the environment and the economy; a long-term approach to planning and decision-making is necessary to harmonize the Province's goals of economic prosperity and environmental sustainability; and
- the management of goals for sustainable prosperity, such as emission reduction, energy efficiency programs and increasing the amount of legally protected land will preserve and improve the Province's environment and economy for future generations."

Key targets specified in this act are 10% less GHG emissions in 2020 than 1990, and economic performance at the Canadian average or better.

5.7.7 Guides

Forest Ecosystem Classification Guide

A systematic ecosystem-based integrated forest management system has been in the works in Nova Scotia since the early 1990s, and in 2010 a comprehensive, provincial three-part Forest Ecosystem Classification (FEC) guide (vegetation types, soil types, and ecosites) was completed (Nova Scotia Department of Natural Resources 2010). Unlike guides in some provinces (e.g., British Columbia), site-specific management interpretations are not included in the guidebooks but a summary of CWD and snag data collected from almost 1500 FEC plots are presented by type (softwood and hardwood) and diameter class, which are correlated with wildlife habitat use and long-term nutrient supply.

Forest Soil Types of Nova Scotia (Keys 2007)

Forest Soil Types of Nova Scotia provides management interpretations related to soil compaction hazard, rutting hazard, erosion hazard, frost

heave hazard, windthrow hazard, and sensitivity to forest floor loss for Nova Scotia soils. The hazard ratings depend on soil texture, soil moisture content, soil organic matter content, soil depth, and stoniness. Interpretations include:

- Soils with high compaction and rutting hazards are best travelled when frozen or during summer dry periods. When moist, these soils can be damaged with even one or two vehicle passes. To minimize damage, treatment plans should minimize the need for machine travel, and traffic damage should be focussed on fewer trails, which are located and designed to withstand high use;
- To avoid erosion on high-hazard sites, forest floor organic layers should be kept intact and compaction and rutting should be minimized;
- To reduce the occurrence of frost heave on high-hazard sites, forest floor organic layers should be kept intact and soil compaction should be minimized; and
- To avoid damaging sites that are sensitive to forest floor loss, mineral soil exposure should be kept to a minimum during all treatment operations.

5.7.8 Protected areas legislation Under the *Parks Act*, the Provincial Parks Regulation (Statutes of Nova Scotia 1989d) specifies that timber may not be cut or removed in a park, except by the Department of Natural Resources for the purpose of development or management of the park. However, parks may be increased or decreased in size, or their status may be terminated. The *Wilderness Areas Protection Act* (Statutes of Nova Scotia 1988) provides for Wilderness Areas, where forestry is prohibited. Nature reserves are small areas (average 200 ha) protected under the *Special Places Protection Act* (Statutes of Nova Scotia 1989e).They protect unique, rare, or outstanding natural features including old-growth forests and habitats of rare or endangered plants and animals. Low-impact activities are generally allowed, but logging is prohibited.

5.8 New Brunswick

5.8.1 The forest biomass resource In 2009, 63 027 ha (7.9 million m^3) of forest was harvested in New Brunswick, which is about one-sixth of the volume harvested in British Columbia in the same year (Natural Resources Canada 2011b). The province is estimated to have 0.848 million BDT p.a. of roadside residues, or one-sixteenth the amount in British Columbia (Bradley 2010).

5.8.2 Land ownership New Brunswick is made up of 50% private land, 48% provincial Crown land, and 2% Federal (Natural Resources Canada 2011b). This section focusses on Crown land with some information related to private land also included.

5.8.3 Status of forest biomass harvesting policy New Brunswick was the first Canadian jurisdiction to have a specific forest harvesting biomass policy. New Brunswick's Crown Land Forest Biomass Harvesting Policy (New Brunswick Department of Natural Resources 2008) was released in 2008, following 2 years of development by the Department of Natural Resources in conjunction with the University of New Brunswick. Forest biomass was

defined as "all the above-ground components of a tree that are not identified under the current Department of Natural Resources utilization standards for Crown Land. Forest biomass includes residual tree tops, branches, foliage, non-merchantable woody stems of trees and shrubs, pre-existing dead wood material and flailing chipping residue. Pulpwood fibre generated from full-tree chipping is not considered biomass under this policy." The overarching policy statement is: "It is the policy of the Department of Natural Resources to permit harvesting of forest biomass from Crown lands while ensuring the sustainable management of Crown forests." The direction of the policy may change as more information becomes available about the effects of removing forest biomass on forest growth and ecological values.

In the policy, a forest stand's eligibility for biomass harvesting is determined with the GIS-based Forest Biomass Decision Support System, which uses the most current information available relating to soils, climate, and forest growth and yield. The model uses soil type, bedrock type, atmospheric nutrient deposition, and tree nutrient content information to calculate the total nutrient supply for a forest stand. Nutrient demand is also calculated, using information about forest composition and associated stand growth. The impact of removing biomass on forest growth is then calculated as the total available nutrient supply minus the nutrient demand to sustain a pre-defined growth rate of a given stand. The GIS-based information is verified and combined with information collected on the ground including soil depth, depth to water table, and current stand conditions, and all of the information is used together to assess biomass sustainability.

Highlights of the Crown Land Forest Biomass Harvesting Policy are:

- New Brunswick Crown forests are to be managed in a sustainable manner to ensure that objectives set forth for forest diversity, wood supply, wildlife habitat, watercourses, and wetlands are achieved. Forest biomass harvesting is permitted on eligible areas but must work within the framework of sustainable forest management;
- Forest biomass harvesting operations are to be done in accordance to the Forest Management Manual (New Brunswick Department of Natural Resources 2004) and other related Crown land policies and directives related to forest management;
- Biomass removal is limited to harvest blocks of the current, approved forest management plan;
- Stands are eligible for biomass harvesting when the operation will result in minimal site nutrient loss and therefore no reduction in the predicted growth of the future forest;
- Under the current Crown land management framework, harvest and silviculture planning are separate processes, so the biomass sustainability analysis does not include the impact of silviculture treatments;
- Biomass harvesting sustainability for all forest stand types will be assessed over an 80-year time period (the life span of an average forest stand);
- Forest stands that qualify for biomass harvesting are to be spatially defined;
- Biomass harvesting at the forest stand level may be impractical because harvest blocks are composed of multiple forest stands. An entire block

can be harvested when the area of eligible stands within it make up more than 90% of its area. Alternatively, eligible forest stands can be harvested to their boundaries within the block;

- Forest biomass harvesting must not occur on ineligible or "high-risk" areas, which are wetlands, sites with shallow (< 30 cm depth), dry, or poor soils, and rocky and stony areas;
- Forest biomass harvesting is limited to harvest of residual tree tops, branches, foliage, non-merchantable woody stems of trees and shrubs, pre-existing dead woody material, and flail chipping residue;
- The forest floor, including the litter layer, soil surface, stumps, and root systems, must not be removed;
- As a best practice, foliage should remain on the site;
- Harvest systems must be designed to minimize soil disturbance, including compaction, rutting, and erosion;
- Harvest slash material that is not intended to be utilized must be evenly distributed across the harvest block (same requirement as for full-tree forest operations in biomass-ineligible areas);
- Slash material must not be left at the roadside;
- Roadside harvest residue material on previously logged blocks (pre-2008) is eligible for removal as forest biomass;
- All forest biomass must be removed from the harvest block within 1 operating year;
- Crown Timber Licensees are required to identify all forest stands in which biomass harvesting is to occur, in a block operating plan submission;
- Licensees must implement and monitor their harvest operations, including forest biomass removal, to ensure that departmental standards, policies, goals, and objectives for Crown Land are met; and
- The Department of Natural Resources will audit biomass eligibility and harvest to ensure that departmental standards and guidelines are adhered to.

5.8.4 Existing forest biomass harvesting In early 2009, the New Brunswick government issued a request for proposals from parties interested in gaining access to forest biomass material from Crown forests (branches, tree tops, and foliage). The response was very good, with 16 proposals received, which was far more than the level of biomass that could be harvested on a sustainable basis (Canadian Biomass Magazine 2010). In June 2010, eight allocations of Crown forest biomass were awarded to New Brunswick companies, primarily for co-generation. The total allocation was 1 276 000 m^3 of biomass, or enough to displace about 200 million litres of oil (Pulp and Paper Canada 2010). At least one mill (Twin Rivers Paper Co. in Edmundston) is producing electricity for both its pulping operations and to sell to NB Power. In February 2010, in support of the Climate Change Action Plan (Province of New Brunswick 2007), the New Brunswick government announced the Community Energy Policy (New Brunswick Department of Energy 2010) to encourage the development of locally owned and operated renewable energy projects. Community Energy Policy projects must be under 15 MW and majority-owned by New Brunswick–based First Nations, municipalities, co-operatives, associations, or not-for-profit organizations. New Brunswick–based private corporations and investors can be minority

participants. The first phase will allow up to 75 MW of community energy projects, of which 25 MW will be allocated to First Nations. Energy sources could be biomass, wind, solar, small hydro, or tidal power. Proponents must demonstrate availability and access to the energy resources being considered and present a viable business case.

However, in spite of these recent developments, provincial agencies have been slow in pursuing opportunities for biomass heating and combined heat and power operations in schools, hospitals, and other medium-scale facilities that would benefit from fuel switching (Floyd et al. 2012). Discussions with mill owners, marketing boards, and woodlot owners, as part of the research for that report, indicated that much of the current economic development strategy focusses on maintaining the pulp and paper and commodity lumber sectors, with "inadequate" attention paid to productive use of biomass or adequate investment in engineered and composite wood products and technologies.

5.8.5 Energy strategies, initiatives, and policies

Electricity Act

The Electricity from Renewable Resources Regulation (Statutes of New Brunswick 2006) issued under the *Electricity Act* requires NB Power to acquire 10% of its electricity supply from new renewable sources by 2016. Wind, solar, biomass, small hydro, landfill gas, and ocean are eligible.

Climate Change Action Plan (Province of New Brunswick 2007)

In June 2007, the New Brunswick government launched its Climate Change Action Plan, which outlined a series of actions to reduce provincial GHG emissions, to adapt to impacts of climate change, and to encourage participation of communities and citizens. The plan calls for a reduction in New Brunswick's GHG gas emissions to 1990 levels in 2012 and further reductions of 10% below 1990 levels by 2020. A commitment to implement a Crown land forest biomass policy was included in the policy actions to achieve these goals. The success of the Climate Change Action Plan in reducing GHG emissions was most recently reported on in October 2011 in the document New Brunswick and Climate Change–On Track to 2012 (Province of New Brunswick 2011). Accomplishments included the awarding of eight allocations for Crown land forest biomass in mid-2010 (see above).

5.8.6 Policies/strategies related to sustainability Several documents present New Brunswick's goal of sustainable forest management.

A Vision for New Brunswick Forests: Goals and Objectives for Crown Land Management (New Brunswick Department of Natural Resources 2000)

The Minister of Natural Resources is responsible for the management of resources on Crown lands and the mission of the Department is "To manage the natural resources of the Province in the best interest of its citizens." The philosophy, principles, and direction to be followed in the management of Crown forests in New Brunswick were set out in A Vision for New Brunswick Forests in 2000. Policy goals to meet the mission statement are: "to account for public values on Crown land," "to

maintain the diversity of forest ecosystems and their associated ecological values," to "provide habitat necessary to support populations of native wildlife species at desired levels across their natural ranges," "to maximize the long-term economic benefits from the sustainable timber supply while meeting identified non-timber objectives," "to protect water quality and maintain aquatic habitat for fish and wildlife species," and "to provide for recreational opportunities on Crown land." Strategic actions for wildlife habitat included: "Ensure forest management activities provide the amount, quality and distribution of identified habitats to meet population objectives for all native vertebrate species," "Develop quantitative habitat objectives for selected wildlife species or species groups for inclusion in forest management" and "Protect the habitat of endangered species." Timber objectives included "minimize waste on harvest operations" and water objectives included "maintain buffers around lakes and along watercourses." Soils were not addressed. The Forest Management Manual for New Brunswick Crown Land (New Brunswick Department of Natural Resources 2004) lists operational standards, criteria, and procedures to meet the objectives (see below).

The New Brunswick Public Forest: Our Shared Future (New Brunswick Department of Natural Resources 2005c)

The New Brunswick Public Forest: Our Shared Future again defines the philosophy, principles, and direction to be followed in forest management, which echoes that of the 2000 Vision for New Brunswick's Forests.

Charting our Course: A Strategic Plan (New Brunswick Department of Natural Resources 2005a)

This plan, released in July 2005, described the Department of Natural Resources focus over the next 3–5 years, which included managing the province's resources in accordance with the objectives set out in The New Brunswick Public Forest: Our Shared Future. Sustainable use of natural resources on both Crown land and private woodlots was identified as a key area, and included sustainable management for fish and wildlife and biodiversity. Soils were not specifically addressed.

Objectives and Standards for the New Brunswick Crown Forest for the 2007–2012 Period (New Brunswick Department of Natural Resources 2005b)

Objectives and Standards for the New Brunswick Crown Forest for the 2007–2012 Period builds on the strategy for management of the Crown forest in New Brunswick as defined in The New Brunswick Public Forest: Our Shared Future, setting out in more detail the objectives identified by the New Brunswick government that licensees must fulfill in their 2007–2012 management plans, but neither document specifically addresses woody forest biomass or soils.

Biodiversity Strategy: Conserving Biodiversity and Using Biological Resources in a Sustainable Manner (New Brunswick Department of Natural Resources 2009)

This strategy, released in June 2009, provides a broad level of direction that reaffirms the commitment to biodiversity that was made in the Canadian Biodiversity Strategy (1995) (described earlier). Sustainable use

of New Brunswick's forests is defined as including the use of a biological resource (and the supporting soil and water) in a manner that allows its continued use.

Crown Land Management Principles (New Brunswick Department of Natural Resources 2010)

Crown Land Management Principles states that "Crown lands and resources will be utilized in a manner and to an extent that such use does not result in long term negative environmental, economic, or social impact" and "Renewable resources will be utilized at a level, and in a manner that ensures their continued availability. Sustainable development also includes measures to prevent environmental degradation and mitigate damages that have occurred." This specification for sustained management does not apply to private land, which comprises half of New Brunswick's forests (see below for discussion of private land).

5.8.7 Natural resource legislation

Crown Lands and Forest Act (CLFA) (Statutes of New Brunswick 1982)

The Ministry of Natural Resources is responsible for the development, utilization, protection, and integrated management of the resources of Crown lands under the *Crown Lands and Forest Act* and its regulations. The Forest Biomass Harvesting Policy is subject to this act.

Timber Regulations

The Timber Regulations (Statutes of New Brunswick 1986) of the CLFA define timber waste and the amount of waste that may be left on a block. Penalties for leaving more than this amount of wood on a block are:

- For stumps > 30 cm high; $2 per stump;
- For not cutting a merchantable tree species as identified in an operating plan or taking to the roadside any merchantable piece, $2 per merchantable tree or merchantable piece;
- For leaving at the roadside any merchantable piece for more than thirty days after having been given notice in writing by the Minister to remove it, $2 per merchantable piece;
- For long-butting any merchantable tree that is not a cull under the *Scalers Act*, $2 per merchantable tree or portion; and
- For cutting or damaging any tree not specified to be cut in an operating plan, $2 for each tree cut or damaged, in addition to four times the royalty for that class of timber.

5.8.8 Forest management manuals

Forest Management Manual for New Brunswick Crown Land (New Brunswick Department of Natural Resources 2004)

This detailed manual, completed in 2004, sets out standards, criteria, and procedures for forestry operations on Crown land and forms part of the Forest Management Agreement for Licensees. A few of the specifications that are particularly relevant to forest biomass harvesting are:

- There may be a penalty if the total merchantable waste exceeds an average of 3.0 m^3/ha or 3% of the harvested volume;

- Harvest slash and chipper de[illegible] shall be distributed so it does not pose a significant fire hazard [illegible] hibit regeneration;
- Old spruce–fir habitat blocks: To ensure a supply of CWD, no more than 30% of the dead trees standing or on the ground may be harvested;
- The surface of roads shall not normally be used for landing areas. If road rights-of-way are used as landing areas, the operator shall restore them to the standards when the operation is completed;
- Harvesting of steep slopes must be done according to the Steep Slope Harvesting Standards;
- Area bared to mineral soil and/or covered with windrowed material shall not exceed 5% of the harvested area;
- Reasonable effort must be taken to avoid rutting. Rutting is not defined;
- No trees, tops, slash, debris, or primary forest product from a harvesting operation shall be felled into, or allowed to enter, a natural watercourse;
- To maintain a natural source of woody debris falling into a watercourse and snags in the remainder of the buffer zone, no more than 30% of the dead and dying trees, standing or on the ground, shall be harvested from a buffer in any 10-year period. This also applies to salvage harvest operations within buffer zones;
- Trees with cavities must not be harvested;
- No more than 30% of the merchantable stems and basal area shall be removed in any 10-year period while maintaining basal area $\geq 18\ m^2/ha$;
- In general timber harvesting should remove merchantable trees from across the range of species, stem sizes (dbh), and tree conditions present in the buffer zone. However, favouring of longer-lived and deep-rooted species such as tolerant hardwoods, eastern hemlock, eastern cedar, and white pine is preferred;
- Damage to residual trees, advanced regeneration, shrubs and ground-layer vegetation caused by forestry activities must be minimized in the buffer;
- Canopy openings in buffers must not exceed 10 m and the operator must retain at least 50% of pre-harvest canopy cover;
- Partial harvesting in buffers is not allowed for the following types, except where authorized: Over-mature balsam fir stands, mature balsam fir stands where the buffer width is ≤ 30 m, over-mature spruce stands where the buffer width is ≤ 30 m, mature and over-mature conifer stands on poorly drained sites where the buffer width is ≤ 30 m. Salvage logging may be allowed in special circumstances;
- Buffer zone standards depend on the objective of the buffer (water quality and aquatic habitat in all cases, and sometimes wildlife travel corridors and aquatic recreation and aesthetics) and modifiers including watercourse size, fish habitat values, wildlife values, windthrow potential, slope of the bank, and recreation values;
- Regardless of the watercourse width, no harvesting of non-merchantable wood shall be undertaken in a right-of-way area within 10 m of the watercourse excluding the roadbed;

- Trees may be selectively harvested and salvaged from buffer zones, as approved in the Operating Plan, as long as the buffer's ability to fulfill its objective is not compromised;
- In order to ensure that the functionality and stability of a buffer is maintained, rutting of the ground and exposure of mineral soil within the buffer zone shall be minimal. Mineral soil exposed through forestry operations, including road building and maintenance, which can enter a natural watercourse, shall be stabilized immediately;
- Wood shall not be piled down within 30 m of a natural watercourse greater than 0.5 m in width or within 15 m of a natural watercourse less than 0.5 m in width;
- No vehicle may go through or in a natural watercourse except for approved road-building purposes;
- Vehicles shall not travel within 15 m of the bank of a natural watercourse with a channel width ≥ 0.5 m, or within 3 m of a natural watercourse with a channel width < 0.5 m; and
- Buffers must be left beside heron and raptor nests; no more than 30% of the BA may be harvested in the buffers. Buffer radii are 15–100 m, depending on species, and 100–200 m during nesting season.

5.8.9 Private land Fifty percent of forested land in New Brunswick is privately owned. Staff and funding from the Department of Natural Resources have concentrated on Crown land management and policies are not the same on private and publicly owned land. Private lands are not subject to the *Crown Lands and Forest Act* and the private woodlots are largely unregulated by the Crown, except for riparian buffers, water crossings, and lands within designated drinking water supply areas. A survey in the summer of 2011 revealed that only a small proportion of private land owners generate income from their woodlots (18%), use a written forest management plan (13%), or conduct management activities that are financially supported by the provincial government or regional marketing board (13%), although in each case, likelihood increases with woodlot size (Floyd et al. 2012). The study concluded that forest management on woodlots could use much improvement, and recommended creating a province-wide system of registered working woodlots, whereby owners would agree to develop and implement a sustainable forest management plan that includes both habitat and fibre production objectives. In return, these owners would be eligible for technical assistance and services from forestry professionals. Most respondents to the survey indicated a willingness to participate in sustainable management on their woodlots.

5.8.10 Protected areas legislation Provincial parks in New Brunswick are set up under the *Parks Act* (Statutes of New Brunswick 2011), but can be terminated, decreased, or increased in size. The removal of any animate or inanimate object from parks is prohibited, except with a permit for management or scientific purposes.

The *Protected Natural Areas Act* (Statutes of New Brunswick 2003) allows for the creation of two categories of protected areas, called Class I and Class II. Areas in both categories are protected from all forms of development, including construction, road building, mining, and forestry. Class I

areas, of which there are four small ones, are areas deemed very sensitive and are therefore restricted areas requiring provincial permits to enter. They are permanently set aside for biodiversity. Class II areas are also for conservation of biodiversity, and "forestry activities" are not allowed but they but remain open to outdoor recreation.

5.9 Prince Edward Island

5.9.1 The forest biomass resource Prince Edward Island is Canada's smallest province with an area of 5 684 km^2. In 2009, 2133 ha (404 000 m^3) of forest was harvested (Natural Resources Canada 2011b). Prince Edward Island's forest is classified as Acadian Forest, a temperate broadleaf and mixed forest ecoregion (Prince Edward Island Department of Agriculture and Forestry 2012a). The 2000 Forest Inventory found that the total forested area (including sites where the forest had been harvested, but where it could not be determined if the site would be allowed to return to forest or if it would be converted to another use) was 45% of the province or 255 780 ha.

5.9.2 Land ownership Public lands account for approximately 12% of Prince Edward Island's forest area (about 31 000 ha) (Prince Edward Island Department of Agriculture and Forestry 2012a). Most (88% or 225 086 ha) of Prince Edward Island's forest is owned and managed by about 16,000 private woodlot owners. Private land owners use and manage these lands for many purposes such as fuelwood, recreation, income, stewardship, and family connections.

The Provincial Forest system covers some 21 732 ha (of which 18 900 ha is forested) and consists of 22 Provincial Forests and 187 satellite properties. The Satellite Provincial Forest properties contain research plots, tree improvement orchards, demonstration woodlots, natural areas, and heritage roads, and provide vital employment opportunities in rural areas.

5.9.3 Status of forest biomass harvesting policy The Department of Environment, Energy and Forestry has developed Biomass Guidelines to illustrate the requirements that biomass operations would have to meet to secure public funding or support (Prince Edward Island Department of Environment, Energy and Forestry 2009). For projects with no public investment, the only requirement is compliance with existing legislation such as the *Environmental Protection Act* and the *Wildlife Conservation Act*.

Public investment in biomass projects would include grants or loans for start-up, capital or operating costs, silvicultural or other land management incentives provided through government programs, or green credits or certification from government. For biomass projects with public investment, the requirements include:

No land conversion (site will remain in forest production)

- Harvest sites require a pre-harvest management plan meeting standards in the Ecosystem-based Forest Management Manual;
- Harvests must be in compliance with standards in the Ecosystem-based Forest Management Manual;
- For clearcut harvests, only the tree bole may be removed with branches and foliage spread on site (no whole-tree removal);
- For commercial thinning and other non-clearcut harvest, whole-tree harvest is allowed but stumps must be left on site; and

- All biomass harvest sites must be mapped via GPS and maps filed with Forests, Fish and Wildlife Division.

Land conversion (site will become agricultural or other non-forest use)

- Clearcut harvests on sites being converted to agriculture or other non-forest use are exempt from standards; and
- Conversion must occur within 10 years or penalties may be levied.

5.9.4 Existing forest biomass harvesting Ten percent of energy in Prince Edward Island is supplied by biomass including wood, sawmill residue and municipal waste. Firewood is the most widely used biofuel in Prince Edward Island. In 2009 the Island's fuelwood harvest was estimated at 230 000 m^3 (100 000 cords) (Environmental Advisory Council–Public Forest Council Joint Working Group on Biomass Heat 2010). However, the province also has a long history in the biomass and woodchip fuel sector. In the 1980s, concerns over energy costs and the security of supplies led the Island to develop a state-of-the-art, biomass-based district heating system (Prince Edward Island Department of Agriculture and Forestry 2012b). Prince Edward Island Energy Systems, in Charlottetown, uses municipal waste and wood biomass to supply thermal energy to commercial, residential, and institutional buildings in the city (Natural Resources Canada 2009). Thirty percent of the fuel requirements for district heating systems in Charlottetown are from wood chips (Environmental Advisory Council–Public Forest Council Joint Working Group on Biomass Heat 2010). The Charlottetown district heating system is the largest in Canada and currently displaces over 16 million litres of heating oil annually and about 15 000 tonnes of carbon dioxide (McCallum 2010).

Islanders also wanted to use forests as an economic development tool and saw wood chips as a secure, local supply of cheaper renewable energy (Prince Edward Island Department of Agriculture and Forestry 2012b). Forests on the Island contained tens of thousands of hectares of white spruce that had grown on abandoned fields. These old-field white spruce stands were suited to use as low-grade biomass and this created markets, employment, and some energy independence.

In the 1990s, world oil prices collapsed, which reduced interest in biomass energy, and the demand for softwood building materials created new markets for the old-field white spruce. This increased the price of the raw product and made biomass uneconomic. By 2008, the Government of Prince Edward Island (Prince Edward Island Department of Environment, Energy and Forestry 2008a) considered that wood from Island forests (including softwood, hardwood, postharvest material, plantation thinnings, and roadside material) could represent a fuel source for space and water heating. Most recently, the Prince Edward Island Energy Commission determined that with excess capacity in the region and the availability of low-priced, natural gas–generated electricity, wood biomass generation simply could not compete (Prince Edward Island Energy Commission 2013).

In September 2012 the province put out a request for proposals for biomass heating projects (CBC News 2013). Atlantic BioHeat is hoping for a sizable expansion of its operation that uses wood chips harvested from Island forests to heat government buildings. It is already heating the Evangeline and West Isle schools with biomass and is trying to win a 20-year contract with

the government to heat up to 32 publicly owned buildings. The feedstock source for this venture would be from thinning forests on the Island and the company estimates that thinning just 3% of the province's forests would provide enough wood chips to run the 32 furnaces for 10–15 years, which would save burning about 4 million litres of oil per year.

A pilot project in Prince Edward Island has been studying the viability of willow production for biomass fuel to help heat farms. Farmers would plant willow in sensitive areas and harvest it every few years for wood chips. The plants keep growing back and grow about 10 times faster than hardwood trees. They are desirable for heating because they have a high heat value (Farm Focus 2013).

5.9.5 Energy strategies, initiatives, and policies

Renewable Energy Act (Statutes of Prince Edward Island 2004)

The *Renewable Energy Act* specifies that beginning on January 2010 every public utility in Prince Edward Island shall obtain at least 15% of the total amount of electric energy that it sells during a year from renewable energy sources.

Prince Edward Island Energy Strategy. Securing Our Future: Energy Efficiency and Conservation (Prince Edward Island Department of Environment, Energy and Forestry 2008a)

This strategy was intended to reduce dependence on fossil fuel energy sources through improved energy efficiency and increased reliance on wind power and renewable biomass from forestry and farming operations. Timelines included that by 2010 utilities must acquire at least 15% of electrical energy from renewable sources. By 2013 there shall be a 50% increase in biomass use, leading to 10 MW of new electricity generation capacity. The province's renewable energy portfolio standard shall double from 15% to 30%. By 2020 they are aiming for a 10% reduction in GHG emissions below 1990 levels. By 2025 they plan to reduce the amount of CO_2 emitted per megawatt hour of electricity use by 20% of current emissions.

Climate Change Strategy (Prince Edward Island Department of Environment, Energy and Forestry 2008b)

The province's Climate Change Strategy recommended increased emphasis on renewable energy and wind. The provincial government committed to four actions related to biomass (wood, sawmill residue, and municipal waste): (1) To review and improve codes and regulatory barriers preventing the sustainable development of biomass fuel and biogas facilities; (2) To lead by example in demonstrating biomass and biogas technologies in public buildings and facilities; (3) To promote the use and encourage the installation of biomass heating systems in homes and businesses through loans, tax breaks, and other financial incentives; and (4) To undertake feasibility studies for the use of biomass and biogas in urban and local community district heating systems and for the potential for co-generation facilities with the Island utilities.

Biomass Heat on P.E.I.: A Path Forward (Environmental Advisory Council and Public Forest Council Joint Working Group on Biomass Heat 2010)

In 2010 the Government of Prince Edward Island established a Joint Working Committee to review how the province might effectively meet the targets set out in the 2008 Energy Strategy. The Environmental Advisory Council and Public Forest Council Joint Working Group on Biomass Heat considered that the expansion of biomass heat on Prince Edward Island was an opportunity for economic development, revitalization of rural communities, job creation, and new alternatives for the forest sector, which would also reduce greenhouse gas emissions and decrease dependence on fossil fuels. They felt that abundant fuel sources in Prince Edward Island combined with the province's energy needs justify the expansion and exploration of biomass technologies and recommended greater use of biomass for heat. They recommended that at least six 5-year test pilot projects be established across the province to provide initial information to validate the expansion of biomass heat. The projects should represent the three primary biomass feedstock sources on Prince Edward Island: forestry, agriculture, and construction and demolition. They recommended that sustainable and environmental well-being be the most important consideration in analysis of the test pilot projects; economic cost of the energy was considered a less important factor during the testing phase. Proponents would be responsible for the capital costs of installation and operation of the heating units but the provincial government should participate by purchasing heat from the operations. The facilities must be monitored by the Department of Environment, Energy and Forestry for emissions, sustainability of feedstock, maintenance and construction of facilities, and environmental concerns. Biomass feedstock must be harvested within recognized sustainability guidelines, with harvesting done from properties with a current and registered Forest Management Plan prepared according to the standards of the Ecosystem-based Forest Management Manual. They also recommended that provincial forest policy provide more specific definitions of acceptable methods of forest biomass harvesting.

Charting our Electricity Future

The Prince Edward Island Energy Commission was mandated by the Government of Prince Edward Island to provide advice on ways to reduce and/or stabilize the high cost of electricity on the Island over the long term. In its final report, Charting Our Electricity Future (Prince Edward Island Energy Commission 2013), the commission declared that wood biomass generation could not compete economically with low-cost natural gas and its feasibility would also depend upon the sustainability of a long-term local fuel supply.

Forest Enhancement Program (www.gov.pe.ca/forestry/index.php3?number=72560)

The Forest Enhancement Program provides incentives to anyone who owns at least 1 ha of woodland on Prince Edward Island for the preparation of forest management plans and selected non-clearcut silvicultural treatments including commercial and pre-commercial thinning. Many activities under the Forest Enhancement Program are cost-shared

between the provincial government and the landowner and must meet the standards contained in the Ecosystem-based Forest Management Standards Manual (Prince Edward Island Department of Agriculture and Forestry 2012c).

5.9.7 Natural resource legislation

Forest Management Act (Statutes of Prince Edward Island 1988b)

This act enables the administration, policy, Forest Improvement Advisory Council, inventory, trespass rights, management of private forest lands, Crown forest land management, roads, facilities, fuelwood categories, scaling and grading, disease control, forest conservation, market development, forest fire recovery program, liability, and regulations on forest land. The act specifies that a permit is required to cut, damage, or remove timber or other forest products from Crown lands. Restrictions may be placed on the harvesting or extraction of trees within 20 m of a body of water or within 40 m on either side of a designated scenic heritage road.

Provincial Forests Regulations (Statutes of Prince Edward Island 1988c)

These regulations list the parcels of land that are Provincial Forests or Satellite Provincial Forests and establishes that these lands are to be managed in accordance with Crown Forest Land Management Plans.

Environmental Protection Act (Statutes of Prince Edward Island 1988a)

The purpose of this act is to manage, protect and enhance the environment. The Watercourse and Wetland Protection Regulations (Statutes of Prince Edward Island 1988d) specify that a permit or licence is required to operate heavy machinery or a motor vehicle on a wetland or on the bed, beach, or bank of a watercourse, or disturb, remove, alter, disrupt, or destroy the ground or vegetation in any manner, including cutting live trees and shrubs. Similar requirements exist for buffer zones (15-m diameter from all watercourses and wetlands).

5.9.8 Guides

Ecosystem-based Forest Management Standards Manual (Prince Edward Island Department of Agriculture and Forestry 2012c).

This document is intended to be used by forest professionals, including foresters, forest technicians, contractors, and informed woodlot owners, to assist in forest management and improve the quality of publicly and privately owned forests. It includes the Biomass Guidelines (described above), and other guidelines that apply to biomass harvesting, including: (1) All operations must minimize damage to residual stems. Damage is considered to be broken limbs and/or bark damage that exposes greater than 10 cm^2 of sapwood per tree. A maximum of 5% damaged residual trees is allowed per treatment. In seed-tree areas, harvesting and extraction should not be carried out during soft ground conditions to reduce rutting and root damage to residual trees.

P.E.I. Watercourse and Wetland Alteration Guidelines (Prince Edward Island Department of Environment, Labour and Justice 2006)

> These guidelines provide adequate information for the planning and designing of watercourse or wetland alterations to prevent or minimize the impacts of an alteration at the design stage. They state that disturbing firmly embedded logs, branches, or other debris releases sediment into the water and may disrupt the aquatic habitat or cause downstream flooding. When coniferous trees have fallen across a watercourse the limbs should only be removed from the underside of the tree. Cutting and removal of dead trees is permitted in a buffer zone (but a permit for operating machinery is required) but removal of trees that are partly down (blown or fallen but are lodged and/or still alive) requires a permit/review.

5.9.9 Protected areas legislation Protected areas on Prince Edward Island cover 3.4% of the province, or 19 200 hectares (Prospectors and Developers Association of Canada 2008). There is one National Park covering 2 150 hectares, as well as 25 Provincial Parks, 17 Wildlife Management Areas (WMAs) and Nature Reserves. National and Provincial sites prohibit industrial use but it is permitted in WMAs and Nature Reserves. To date, the WMAs cover 5 431 hectares on Prince Edward Island and 10 of them are on publicly owned land. They are protected under the *Wildlife Conservation Act* (Statutes of Prince Edward Island 1998) and are to be maintained for the protection, management, and conservation of wildlife and its habitat. Some are also designated as Natural Areas under the *Natural Areas Protection Act* (Statutes of Prince Edward Island 1988e) and, for these, certain management activities are restricted in order to protect the area's natural features. The Regulations of this act state that Natural Areas are created to conserve the aesthetic, scenic, and natural character and condition of ecosystems, and to prevent their exploitation for commercial purposes. Cutting, destroying, or removing of trees, shrubs, or other vegetation is not permitted, and use of all types of motor vehicles is prohibited. Natural Areas may be on Crown land or private land where landowners have voluntarily agreed to protection.

5.10 Newfoundland and Labrador

5.10.1 The forest biomass resource The total land mass of Newfoundland is 11.1 million ha, of which 5 million ha is forested, although trees are generally small with low yields. Labrador's landmass is approximately 29.3 million ha with 5.4 million ha forested, but at present there is no commercial forest industry in Labrador (Newfoundland and Labrador Department of Forest Resources and Agrifoods 2003; Greene 2011). Of all the Canadian provinces, Newfoundland and Labrador had the fourth smallest area and volume of forest cut in 2009 (Saskatchewan, Manitoba, and Prince Edward Island had less) (about 2 million m^3, 16 992 ha) (Natural Resources Canada 2011b). Newfoundland and Labrador are estimated to have less roadside debris available than any of the provinces (except Prince Edward Island with none) (0.8% of the Canadian total) (Bradley 2010).

5.10.2 Land ownership Ninety-nine percent of Newfoundland and Labrador's forests are publicly owned. However, timber and property rights for 69% of the Crown land on the Island of Newfoundland have been allocated to pulp and paper companies through 99-year licences issued

under the 1905 *Pulp and Paper Manufacturing Act* and 1935 *Bowater Act* and the province's financial and legal system treats this licensed land as private property (Natural Resources Canada 2011b).

5.10.3 Status of forest biomass harvesting policy In Newfoundland and Labrador, there has been considerable focus on developing forest biomass harvesting guidelines in order to minimize the effects of the practice (Greene 2011). Government and industry are working together to develop guidelines that will sustain forests, minimize environmental impacts, and encourage development of the forest biomass industry in the province. Their intention is to take a conservative approach because of the environmental concern of nutrient depletion, the fact that little research has been done related to soil productivity in this area, and the low to medium capability of most of their soils. They recommend that branches and foliage be left on site to sustain nutrient levels as well as provide mats to help reduce ground disturbance by machinery. In special circumstances, such as clearing rights-of-way or harvesting forest stands affected by diseases or insects, this requirement may not apply. Whole-tree harvesting is currently not practised in Newfoundland, nor was it in the past (1992) (Pulkki, no date). The current forest biomass harvesting guideline is to not practise full-tree harvesting, to leave tops and limbs on site, and to retain a certain number of trees per hectare for wildlife and future woody debris recruitment (A. Arsenault, pers. comm., Apr. 17, 2012; information obtained from B. Clarke, S. Greene and F. Knott). There are no specific CWD retention guidelines, but there are waste allowance ceilings of 6 m^3/ha (Province of Newfoundland and Labrador 2008, see residual volumes section) and Corner Brook Pulp and Paper is targeting 3 m^3/ha.

5.10.4 Existing forest biomass harvesting This section is based on information provided by Sean Greene (Greene 2011; S. Greene, pers. comm., May 14, 2102). In response to a decline in provincial markets for pulpwood, Newfoundland's forest industry is starting to adapt by utilizing smaller-diameter trees (pulpwood and smaller), previously non-merchantable species, and dead wood to produce energy and energy-producing products. Whole-tree harvesting is not permitted in Newfoundland so these unmarketable trees are the sources of "energy wood," and logging slash (tops, branches) remains on site. Although Newfoundland is utilizing these new forest resources, Labrador sawmill operations have been curtailed with no commercial forest industry at present. Examples of Newfoundland companies utilizing forest biomass include Corner Brook Pulp and Paper Ltd. (CBPPL), the one, large, long-term tenure holder in Newfoundland and Labrador that has been harvesting forest biomass for the past few years to offset Bunker C oil requirements. Holson Forest Products, on the Northern Peninsula of Newfoundland, recently started making premium wood pellets from sawmill residue and currently un-marketable trees (small-diameter, off-species, and dead trees) while still harvesting sawlogs for their sawmill. It started doing this because CBPPL no longer accepts pulp from the Northern Peninsula. In both cases, harvesting of the biomass is done along with the sawlog logging, so entire stands of small-diameter trees are not being harvested. Allowable Annual Cuts include volumes of sawlogs and pulpwood, so "energy wood" volumes are not currently allocated but are by-products

of traditional pulp/sawlog harvesting. On the Northern Peninsula, "energy wood" equals pulpwood plus small stems and off-species.

5.10.5 Energy strategies, initiatives, and policies

Charting our Course, Climate Change Action Plan (Province of Newfoundland and Labrador 2011)

Goals of the Climate Change Action Plan include reducing GHG emission levels in Newfoundland and Labrador to 10% below 1990 levels by 2020 and 75–85% below 2001 levels by 2050. The strategic framework of the Climate Change Action Plan includes identifying and maximizing opportunities such as development of the province's clean energy resources and developing new technologies, although the plan does not specifically mention the use of forest biomass as an energy source. Forestry is mentioned in the context of the importance of forests as carbon sinks.

5.10.6 Policies/strategies related to sustainability

Forest Service Vision

The Forest Service of Newfoundland and Labrador has the following vision: "The Forests of Newfoundland and Labrador will maintain a sustainable balance of environmental, economic and cultural values desired by society" and "they will provide for viable populations of native species, sustainable yields of forest products and the creation of wealth and employment to support local, regional and provincial economies." Its mission statement is "To manage, conserve, enhance and use the forest ecosystems of Newfoundland and Labrador using adaptive management to ensure its sustainability and productivity within the appropriate balance of values desired by society" (Newfoundland and Labrador Department of Forest Resources and Agrifoods 2003). One of six guiding principles to support the Forest Service's vision and mission statement is that "forest ecosystems are managed to maintain their ecological integrity, productive capacity, resilience and biodiversity."

Twenty Year Forestry Development Plan (1996–2015) (Province of Newfoundland and Labrador 1997)

The Twenty Year Forestry Development Plan (1996–2015) set out two strategies: an emphasis on the importance of ecosystems, and the development of ecosystem-based management and securing of a sustained timber supply. The Provincial Sustainable Forest Management Strategy (Newfoundland and Labrador Department of Forest Resources and Agrifoods 2003) was built on the Forest Service vision and this Plan, and set the direction for moving towards this vision through implementation of sustainable forest management. This document describes the nature and extent of the forest resource, identifies the goals and objectives of forest management and the steps to take to achieve these goals, describes the relationship between the provincial goals, objectives, and strategies to each district Sustained Forest Management (SFM) Plan (which are required for each forest district), and provides overall direction to the district Planning Teams when preparing the SFM plans. One of the strat-

egy's directions is ecologically based forest management, involving consideration of biodiversity (protecting forest ecosystems, special places, and wildlife habitat), healthy forests (maintaining the natural ecological processes and productivity of forest ecosystems), water and soil (protection of soil and water), and global impacts (determining the amount of carbon in the province's forest ecosystems).

Sustainable Forest Management Strategy

The province of Newfoundland and Labrador is working on a new Sustainable Forest Management Strategy (ForestTalk 2012), which will follow the 2003 strategy, again emphasizing the concept of sustainable forest management.

5.10.7 Natural resource legislation

Forestry Act (Statutes of Newfoundland and Labrador 1990a)

Under the legislated *Forestry Act* (amended 2008) the Forest Service of Newfoundland and Labrador has the mandate to manage its forests, including timber and other values. It requires that "a forest management district shall be managed in accordance with the principles of sustained yield forest management," defining sustained yield forest management as "a policy, method or plan of management to provide for an optimum continuous supply of timber in a manner consistent with other resource management objectives, sound environmental practices and the principle of sustainable development." The focus is on managing the whole forest ecosystem. The *Forestry Act* requires that a sustainable forest management plan be prepared for each district, in consultation with other resource departments and the public. Woody debris management is not required in the SFMPs.

Provincial Environmental Protection Act (Statutes of Newfoundland and Labrador 2002)

The *Provincial Environmental Protection Act* also influences forestry activities in Newfoundland and Labrador by requiring that all 5-year operating plans are registered for assessment of their impact on the environment.

5.10.8 Guides

Managed Riparian Zone Prescription for Newfoundland and Labrador (Decker 2004)

Riparian guidelines current to 2004 require:

- A 20-m treed buffer along all waterbodies represented on a 1:50 000 topographic map, waterways greater than 1 m wide not on the map, and intermittent streams. Buffer width is measured from the high water mark;
- No equipment may enter a watercourse;
- No re-fueling or maintenance of equipment within 30 m of a watercourse;

- Silt and debris entering a watercourse should be minimized and immediately mitigated;
- 50-m buffer required around black bear dens;
- 800 m with no harvesting around bald eagle and osprey nesting sites (200 m after nesting season);
- No removal of hardwoods within 30 m of a watercourse occupied by beavers; and
- 150-m buffer around all protected municipal water supplies.

There are many other recommendations, including that all harvesting in the riparian buffer should be done during the initial harvest to reduce the number of times heavy equipment has to travel over the cutblock.

Prescriptions developed in 2004 based on the literature and what is done in the rest of Canada are:

- Residual stand damage < 5%;
- Canopy openings < 10 m^2;
- Machinery not permitted within 5 m of watercourse;
- D[illegible]es: 30% removal of BA using reach-in or insert method. In mi[illegible] stands remove older, balsam fir trees first due to susceptibility to w[illegible]d;
- Wet [illegible]ensitive sites: Limited harvesting using either reach-in method or manual felling with cable winches. Harvesting during winter will limit soil damage;
- Wind-influenced areas: Fir: Removal of 15–20% of older, less windfirm trees. Spruce: Removal of 30% of BA, producing feather edges. Mixed stands: Removal of 30% of BA maintaining all windfirm trees
- Remove oldest, less windfirm trees;
- Leave snags due to habitat importance;
- No harvesting on slopes > 30%. Provincial guidelines specify increasing buffer widths with increasing slope;
- High-density fir stands or spruce stands: 30% removal of BA using reach-in or insert method. Mimic pre-commercial thinning operations. High-density mixed stands: 30% removal of BA using reach-in or insert method. Remove older, balsam fir trees first due to wind susceptibility;
- Low-density stands, all species: Harvest rate should be reduced to limit canopy openings to less than 10 m^2. Low-density mixed stands: Remove older, balsam fir trees first due to wind susceptibility;
- Buffers 20–60 m: Harvesting equipment can enter buffer via narrow inserts perpendicular to watercourse. Equipment not permitted within 20 m of watercourse;
- Buffers > 60 m: Narrow skid trails or "ghost trails" parallel to watercourse will allow harvester to access timber. Ghost trails should be 30 m from watercourse and brush matting should be used on wet, easily compacted soils;
- Single-grip harvesters and feller bunchers can be used for both reach-in method and insert method to access timber;
- Inserted machinery should be on brush matting to limit potential soil compaction and erosion;

- In sensitive areas, manual harvesting with cable winching should be employed; and
- Machinery not permitted within 5 m of watercourse.

Guidelines for Protection of Fresh Water Fish Habitat in Newfoundland and Labrador (Gosse et al. 1998)

This document was produced based on reviews of existing guidelines from local and other jurisdictions, field observations, and recommendations from experts in the environmental and construction fields.

General guidance for forest harvesting are:

- A buffer zone of undisturbed vegetation should be maintained between harvesting activities and watercourses;
- Slash, tops, or any other logging debris should not be left within the high water mark of any watercourse;
- Skid trails and landings should not be located in or adjacent to watercourses;
- Watercourses should not be used for the driving or towing of logs;
- Bridges are preferred for watercourse crossings (may be portable);
- Scarification for silviculture should be done parallel to the natural contours of the land. Scarification at right angles to the land will lead to erosion of unstable soils;
- Forwarder trails (used to transport wood to roadside) should be located to minimize the number of watercourse crossings. Where watercourse crossings are necessary, temporary bridges should be installed;
- To ensure that sediment-laden water does not collect in wheel ruts and discharge into watercourses, mudlogs should be installed across trails before ruts develop. Mudlogs divert water and mud out of the forwarder track and onto the forest floor;
- Mudlogs should be installed close to where the water is entering the forwarder trail and where the ground slopes to one side. A small earthen dam is pushed up with the forwarder blade on an angle across the trail, and a 30 cm diameter log is placed immediately in front of the dam, on the uphill side. If conditions are extremely wet, several of these logs may have to be placed along the trail; and
- If mudlogs become compacted into the ground and are no longer effective, new mudlogs should be installed.

Environmental Protection Guidelines for Ecologically-based Management (Province of Newfoundland and Labrador 2011b)

Environmental Protection Guidelines for Ecologically-based Forest Management define operational requirements to be implemented to protect the environment and non-timber values. They were developed from discussions with resource managers and from the literature. A number of these are applicable to forest woody biomass harvesting, including:

- Complete utilization of trees is required (harvesting to a top diameter of 8 cm and stumps to 30 cm);
- Where markets exist, non-commercial tree species that are harvested should be brought to the roadside;

- Where skid roads and winter roads are constructed, soil disturbance and impacts on waterbodies are to be minimized;
- Trees must be felled away from all waterbodies, and slash and debris should be piled above the high water mark so that it cannot enter waterbodies during periods of peakflow;
- Equipment activity in water crossing areas is to be kept to a minimum;
- No more than 10% of the total productive area in a cutblock can be disturbed. If this limit is exceeded, rehabilitation is required to bring the soil disturbance level to < 10%;
- Harvesting or other heavy equipment are not permitted on waterbodies, wetlands, or bogs;
- Skidding timber through waterbodies is not permitted;
- If forestry operations directly or indirectly result in silt entering a waterbody, it must be dealt with immediately;
- Wherever possible, place slash on forwarded trails while forwarders are operating in an area;
- Where slash is piled into windrows, ensure that the windrows are placed where slash cannot be washed into streams at peak flooding conditions;
- Woody material of any kind (trees, slash, sawdust, slabs, etc.) is not permitted to enter a waterbody;
- There shall be no bulldozing of standing merchantable timber or poor utilization of merchantable softwoods and hardwoods during cutting of a right-of-way;
- Steep areas with high erosion potential should not be harvested;
- In sensitive areas prone to erosion, equipment must have wide tires, or harvesting must be done when the ground is frozen;
- Wherever possible, skid trails should run along contours;
- Where safety is not an issue, a minimum average on a cutblock of 10 trees or snags per hectare is to be left on all sites, with preference given to trees > 50 cm dbh;
- Buffer zones with certain specifications must be established around waterbodies, black bear denning areas, areas occupied by beavers, bald eagle and osprey nests during nesting season, and waterfowl breeding, moulting, and staging areas;
- Harvesting is not permitted within caribou calving areas during the calving period, and the harvest scheduling should be modified during wildlife migration; and
- Areas identified as containing rare and/or unique flora are to be protected from forestry activity by avoiding those areas.

Forest Site Classification Manual (Meades and Moores 1994)

An ecological classification guide for the Island of Newfoundland was published in 1994 (Meades and Moores 1994). There is no ecological classification for Labrador yet. The guide does not include management interpretations and the system is not used to the degree it is in British Columbia (A. Arsenault, pers. comm., May 10, 2012).

5.10.9 Protected areas legislation The *Wilderness and Ecological Reserves Act* (Statutes of Newfoundland and Labrador 1990b) allows for the protection of natural areas. Wilderness Reserves are large protected areas (>1 000 km²) that protect significant natural features and landscapes. Little or no human activity is allowed except outdoor recreation and study. Ecological Reserves are <1 000 km² and protect unique ecosystems, species, or natural phenomena. They allow limited activity such as hiking, scientific study, and educational tours. They are more protected than Wilderness Reserves. No logging is allowed in wilderness areas and no motorized vehicles or equipment are allowed in Ecological Reserves. Under the *Provincial Parks Act* (Statutes of Newfoundland and Labrador 1990c), logging is not allowed in Provincial Parks. However, park size can be increased or decreased, and activities including logging could be allowed.

5.11 Northwest Territories

5.11.1 The forest biomass resource About 70 million ha of the Northwest Territories is south of the tree line (Government of the Northwest Territories 2011b) and, of that, forested land cover comprises 33.3 million ha and encompasses 28% of the Canadian boreal forest (T. Lakusta, pers. comm. Sept. 15, 2012). Work has gone on over the last 15 years to inventory vegetation in the Northwest Territories, and forest inventory data are now available for 10% of the forested area.

5.11.2 Land ownership Most of the forested area is Crown land, about a third is covered by collective land claims, and <1% is privately owned (T. Lakusta, pers. comm. Sept. 15, 2012).

5.11.3 Status of forest biomass harvesting policy There is no specific forest policy relating to forest biomass harvesting. However, the *N.W.T. Forest Management Act* (Government of the Northwest Territories 1988) includes a provision for personal use of five trees <5 m in height per person per year. In addition, the Canadian Charter of Rights and Freedoms states that First Nations people without settled land claims (in the Northwest Territories this includes the Métis and peoples in the south of the territories) have subsistence rights that include tree cutting; about 50% of people in the Northwest Territories claim Aboriginal heritage.

5.11.4 Existing forest biomass harvesting Presently, approximately 30 000 m³ is harvested annually in the Northwest Territories and two-thirds of that is fuel wood. In the Northwest Territories about 60% of homes use at least a portion of wood fuel.

Forintek (2007) evaluated community sawmill opportunities in the Northwest Territories and related business opportunities (e.g., log homes or wood pellets) and concluded that "one centrally located wood pellet plant producing enough products to supply all of the N.W.T. might be justified if enough low cost material is available." The main issues identified were security of fibre supply and delivered cost of the raw material.

There is currently a commercial biomass interest in the Northwest Territories for a northern pellet-making business, which is in the business planning process and working with several First Nations (T. Lakusta, pers. comm. Sept. 15, 2012). The business needs a reliable supply of trees for more than 5 years,

which is leading to the development of creative new policy and management tools as currently there are only annual permits to cut trees and licences for up to 5 years. The Northwest Territories Environment and Natural Resources Department is working with First Nations in the development of First Nations corporate entities focussed on forest management and woody biomass harvesting. The aim is to create Forest Management Agreements for 15+ years between government and First Nations Development Corporations along with a third-party agreement so that use of wood is in place.

Fifteen public buildings have been converted to biomass (wood pellets) for heat energy and more installations are under way (Government of the Northwest Territories 2011a). The Northwest Territories government provides incentives to residents and businesses for conversion to wood pellet heating appliances.

5.11.5 Energy strategies, initiatives, and policies

Energy for the Future: An Energy Plan for the Northwest Territories (Government of the Northwest Territories 2007)

> This plan maintains that while the government supports renewable energy, these energy sources, with the exception of hydroelectric power, will only represent a relatively small share of the total energy supply for the Northwest Territories in the short and medium term. The reliability of fossil fuels, their superior economics for energy production, and the presence of existing capital infrastructure to deliver power will limit the impact of renewable energy solutions in the Northwest Territories and many other parts of Canada.

Energy Priorities Framework (Government of the Northwest Territories 2008)

> This document includes several priority initiatives aimed at reducing dependence on imported diesel for energy. One priority is a commitment to expand the use of biomass, including for electricity generation, building on the past success of wood pellet boilers.

N.W.T. Biomass Energy Strategy (Government of the Northwest Territories 2010)

> It is recognized in this strategy that because the forest industry operates at a very low level and there is therefore no low-cost supply of waste wood, trees would have to be harvested to produce pellets. In addition, wood chips would be available from residues of road building and maintenance, forest thinning for community protection, forest fire burn areas, and pipeline or seismic line cutting; from cardboard, paper, or construction and demolition waste, and from fast-growing willow or poplar. Among the 12 actions recommended in the strategy are: encourage a stable and economic supply of pellets in all the Northwest Territories communities; work with the private sector and Aboriginal development corporations to identify viable business models to produce pellets and/or wood chips in the Northwest Territories; evaluate and quantify wood resources around select communities and determine potential harvesting areas; and install a combined heat and power pilot project in one community by 2012.

A Greenhouse Gas Strategy for the Northwest Territories 2011–2015 (Government of the Northwest Territories 2011a)

This strategy lays out actions the Government of the Northwest Territories will take to reduce GHG emissions in the Northwest Territories. Targets are to stabilize emissions at 2005 levels by 2015, limit emission increases to 66% above 2005 levels by 2020, and return emissions to 2005 levels by 2030.

Along with supporting development of hydro, wind, solar, and geothermal energy sources, the strategy recommends implementation of the Biomass Energy Strategy, increasing sustainable local harvest of wood in the Northwest Territories, and guiding the actions of GNWT departments and agencies with respect to the development of biomass energy systems (heat and electricity).

Greenhouse Gas Emissions Assessment. The Substitution of Fossil Fuels with Woody Biomass in the Northwest Territories (Manuilova and Johnston 2011)

This life cycle analysis (cradle-to-grave) considered three scenarios: (1) Forest bioenergy for home and district heating—production of thermal energy from locally-sourced woody biomass (firewood and wood chips) in the Northwest Territories; (2) Pellet bioenergy for home and district heating—production of thermal energy from imported and locally produced wood pellets; and (3) Heating oil energy for home and district heating—production of thermal energy from imported heating oil.

A Vision for Energy in the Northwest Territories: Developing the 2013 Northwest Territories Energy Plan (Government of the Northwest Territories 2012a)

A priority for the government of the Northwest Territories is examining energy supply options and moving towards greater use of local and renewable energy. It is promoting the development of local sources of wood pellets and other biomass material that could provide much-needed economic activity and employment in the Northwest Territories communities. This document indicates that biomass could eventually be expanded to most communities in the Northwest Territories. In recent years there has been a substantial increase in the use of wood pellets and they are currently being used in many buildings in the Northwest Territories to generate heat, but they are all imported from British Columbia and Alberta. The Northwest Territories current consumption of wood pellets is estimated to be in the range of 12 000–15 000 tonnes per year.

Biomass Investment Announcement (Simet 2012)

In 2012 the Canadian Northern Economic Development Agency and the Northwest Territories Ministry of Environment and Natural Resources announced a multi-year investment of over $5.7 million to create opportunities for a sustainable woody biomass industry in the Northwest Territories. $3.7 million is from CanNor, Aboriginal Affairs and Northern Development Canada, and Natural Resources Canada, and the rest from the Northwest Territories government. The goal of the initiative is to create jobs and growth in northern Canada, particularly in First Nations

communities, reduce energy costs, and reduce dependence on imported fuel. Funding will be used to complete forest inventories and sustainability analyses for broad forest areas.

Public Works and Services Energy Conservation Projects–Annual Report 2011 (Government of the Northwest Territories 2012b)

This document is an annual review and update on the energy conservation actions and initiatives that have been and are being taken by the Department of Public Works and Services. It reports that several major Territorial government buildings were retrofitted with biomass boilers between 2006 and 2012, including the North Slave Correctional Facility in Yellowknife, the highways maintenance garage in Hay River, the health centre in Fort Smith, Thebacha College in Fort Smith, and about nine schools. A number of other biomass projects are currently being developed.

5.11.6 Natural resource legislation

Forest Management Act (Government of the Northwest Territories 1988)

This act enables the administration, transfers and agreements, permits and licences, appeals, enforcement, offence and punishment, and regulations of forestry without affecting Aboriginal rights.

Forest Management Regulations (Government of the Northwest Territories 1990)

These regulations specify details around permits and licences including the free timber cutting permit that allows residents of the Northwest Territories to cut a volume of timber for personal use up to 60 m^3 in each category of fuelwood, fence posts, sawlogs, and 20 trees of any height for transplanting. Free timber-cutting permits are also available to municipal corporations or settlement corporations to cut the timber that they may require for their own use. Timber-cutting charges and reforestation charges are also specified for sawlogs, fuelwood, fence posts, Christmas trees, and transplants. It is required that a timber operator: leave a stump height of no more than 30 cm; cut timber so as to promote reforestation and maintain acceptable wildlife habitat; dispose of all slash, branches, slabs, sawdust and other debris; and leave no waste timber.

5.11.7 Guides

Commercial Timber Harvest Planning and Operations Standard Operating Procedures Manual (Government of the Northwest Territories 2005)

This is not a legal document but is intended to "promote best practices by presenting standards for sustainable forest management in the Northwest Territories" including aspects of understorey and watershed protection, wildlife considerations, and recognition of sensitive sites. Sensitive sites include stands on permafrost, water source areas where soils are not frozen, archeological sites, wildlife trees, and areas of migratory bird nesting. Guidelines that apply to biomass harvesting include:

Understorey protection

Damage to thrifty white spruce understorey trees must be avoided at all stocking densities. Understorey trees that are vigorous, with good form and potential to be crop trees by the second rotation, must be given highest priority for protection.

Waterbody protection buffers

The following no-harvest buffers must be maintained adjacent to waterbodies: (1) Lakes larger than 16 ha: 100-m buffer; (2) Lakes 1–16 ha area: 30-m buffer; (3) Ponds less than 1 ha in area: 10-m buffer; (4) Large permanent rivers: 100-m buffer; (5) Medium permanent rivers: 60-m buffer; (6) Small permanent rivers and streams: 10-m buffer. A 10-m "machine free" zone must be maintained adjacent to intermittent and ephemeral streams, draws, and water source areas. Equipment is to cross waterbodies only at approved locations. Buffers may be enhanced with an additional machine free zone to protect specific resources.

Sensitive sites and special protection areas: Sites susceptible to degradation resulting from vegetation removal or impacts of heavy machinery must be identified and managed to maintain site integrity. Areas where water, soils, vegetation, or archeological sites will be permanently altered by harvesting activity must be avoided. Clearcut harvesting must not occur in stands on permafrost or water source areas where soils are not frozen. No operations are allowed within 60 m of an archeological site. If resource values can be maintained following harvest, alternative harvest methods may be approved on sensitive sites. Wildlife trees must not be disturbed. Harvesting operations must not occur during the period when migratory birds are nesting.

Skidding and forwarding

All skidding and forwarding must be confined to designated trails when understorey protection of white spruce regeneration is a harvesting condition. Designated trail width is not to exceed 7 m and designated trails are not to exceed 25% of the cutblock area.

Ecosystem Classification Guides

The Northwest Territories is developing an ecologically based landscape classification for environmental assessment, cumulative effects management, biodiversity monitoring and reporting, forest resource analysis and planning, wildlife habitat evaluation and conservation, and protected areas identification. The Ecosystem Classification Program began in 2004 and is expected to be completed in 2013. Classification has been done to the ecoregion level. Small-scale ecosystem units equivalent to site series in British Columbia have not been described and management interpretations are not provided.

5.11.8 Protected areas legislation

Northwest Territories Protected Areas Strategy (Northwest Territories Protected Areas Strategy Advisory Committee 1999)

The Northwest Territories Protected Areas Strategy (PAS) outlines a community-based process to establish a network of protected areas across the Northwest Territories. It recognizes the need to balance conservation and economic development, while respecting Aboriginal rights, third-party interests, and land use planning processes. The two main goals in the strategy are: (1) to protect special natural and cultural areas, and (2) to protect core representative areas within each ecoregion. In 2009, Saoyú-ʔehdacho near the community of Déljne became the first protected area established under the PAS.

The area protected in the Northwest Territories (as of 2010) is approximately 12 million ha, or 8.9% of the territory (Environment Canada, n.d. a) Existing Federal protected areas includes National Parks and Saoyú-ʔehdacho National Historic Site, Migratory Bird Sanctuaries, and Marine Protected Areas. The Northwest Territories has four National Parks, covering 7.1 million ha, where industrial activities are not permitted. Although there are currently no National Wildlife Areas, five candidate areas are proposed to be protected under the *National Wildlife Act* that are in various stages of the PAS process. The Wildlife Area Regulations (Statutes of Canada 2010) identify prohibited and permitted activities in National Wildlife Areas. Motor vehicles and all industrial and commercial activity are prohibited in all of them, except with a permit. National Wildlife Areas are created and managed for the purposes of wildlife conservation, research, and interpretation. There are about 45 Territorial Parks and three Wildlife Reserves covering 3 million ha. Territorial Parks are divided into four different categories: Heritage Parks, Natural Environment Parks, Recreational Parks, and Wayside Parks. Activities permitted within Territorial parks were not determined due to limited online access to the *Territorial Parks Act*. There are also Ecological Reserves, which are small areas with a high degree of protection where no industrial activities are permitted.

Protected areas in the Northwest Territories are managed under the legislation establishing them (e.g., *National Parks Act* (Statutes of Canada 2000), *Canada Wildlife Act* (Statutes of Canada 1985), *Migratory Birds Convention Act*, *Oceans Act*, and *Territorial Parks Act*).

In addition to the areas already protected, another 18.9 million ha have been proposed for withdrawal or withdrawn from industrial use under first Nations Agreements, future National Parks, and candidate protected areas (Prospectors and Developers Association of Canada 2007).

5.12 Yukon Territory

5.12.1 The forest biomass The total land area of Yukon Territory is 47.4 million ha (www.gov.yk.ca/aboutyukon). A substantial portion of Yukon is located south of the treeline, with roughly 57% or 270 000 km² of land covered by the boreal forest. Of that, 81 000 km² has tree cover that can support timber harvesting activities. The remainder of the territory is characterized by taiga, tundra, and alpine regions (Government of Yukon

2012a). The current commercial harvest activity is concentrated in the Haines Junction area due to the presence of beetle-killed spruce forest and its proximity to the populated centre of Whitehorse.

Green trees may not need to be harvested for biomass because of the abundance of dead trees from forest fires and spruce beetle infestations. Forest fires typically kill over 1 000 km² of forest in Yukon each year and there are about 2 200 km² of beetle-killed forest in the Haines Junction area (Preto 2011). Annual forest fires result in enough dead trees to supply 600 000 tons of wood pellets per year; 10% of this would supply the entire heating needs of every building in Yukon (Brand 2010).

5.12.2 Land ownership Yukon is comprised of public land, First Nation settlement land and privately owned land as well as some Federal land, such as National Parks. First Nation settlement lands (Category A and B and fee simple) total more than 3.8 million ha.

5.12.3 Status of forest biomass harvesting policy There is no specific policy relating to forest biomass harvesting in Yukon. *The Forest Resources Act* and Forest Resources Regulation came into effect on January 31, 2011, replacing the Timber Regulation under the *Territorial Lands (Yukon) Act*. The *Forest Resources Act* and accompanying regulations guide decision making and provide forest managers with the tools they require to manage Yukon's forest resources for long-term sustainability and ecosystem health.

5.12.4 Existing forest biomass harvesting The Yukon forest industry is made up of small operators who cut small volumes of timber for building materials, log homes, and fuel (Government of Yukon 2012a). There is currently no land being managed privately for forestry purposes in Yukon but small volumes of timber may be salvaged when land is converted to agricultural designation. The combined Allowable Annual Cut and Annual Limit for Yukon is >250 000 m³ (Government of Yukon 2012a) but in 2010 only 27 000 m³ were harvested and of that 21 000 m³ was fuel wood or firewood and 6 000 m³ industrial round wood (Government of Yukon 2012a).

Most fuel wood comes from beetle kill in the Haines Junction area, and the second most common source is wood salvaged from fire kill throughout Yukon (G. Cowman, pers.comm., Mar. 4, 2013). There is some use of industry residues for fuel wood, and many small mills use slabs and edgings for heating. In some areas where dead trees are not available or in short supply, there is some harvesting of green trees for fuel wood.

At least 12 000 cords of firewood are consumed annually in Yukon (Government of Yukon 2009) and in 2005 wood was the principal heating source for 18% of households in Yukon (PBrand Bioenergy Consulting 2009).

The Champagne and Aishihik First Nations, the Dakwakada Development Corporation, Yukon Energy, Cold Climate Innovation of Yukon Research Centre, and the Village of Haines Junction are working together to investigate the potential for a 2–3 MW biomass plant in Haines Junction that would provide electricity and also have the potential to produce heat (Yukon Energy 2012). Preliminary research shows that this is an economically viable project and a consulting company has been hired to conduct a more detailed engineering and design study. This is in contrast to the conclusion made by PBrand Bioenergy Consulting (2009) that biomass electricity production

does not appear to be a reasonable option for Yukon, although they did note that because the industry is changing rapidly it could be feasible by 2013. Morrison Hershfield (2011) evaluated opportunities to generate electricity in Yukon using woody biomass as an energy source and concluded that there was sufficient biomass feedstock (beetle- and fire-killed wood) within a 250-km radius of Whitehorse to maintain a 25 MW electrical generating facility for 20 years. However, they note there is a significant project risk because a large capital investment is required and forest tenures are not necessarily for 20 years. Policy and regulatory changes would be needed to provide security of feedstock. Analysis of harvesting methods, feedstock preparation, and transportation logistics would also be required to provide more certainty about costs.

There is currently no wood pellet production in Yukon (G. Cowman, pers. comm., Feb. 19, 2013) but over a decade ago small-volume wood pellet production began at Teslin (PBrand Bioenergy Consulting 2009). The pellets were reported to be of good quality and in demand by local consumers but the venture shut down. A contributing factor was that inexpensive and good-quality feedstock was not available, so green forest material that required drying was used. There is not an adequate supply of wood shavings or hog fuel in Yukon, so fibre for pellets must come from the more expensive round-wood sources; for example, fire- or beetle-damaged wood. Although there are no local wood pellet producers in Yukon, a wood pellet market is developing. The first institutional wood pellet boiler has been installed at the new Whitehorse Correctional Centre (Government of Yukon 2011a). Household use of pellets is also increasing (Brand 2010).

Approximately six biomass boiler installations were in the planning stage as of 2010 (Brand 2010). Institutional buildings in Yukon with wood boilers are Elijah Smith School, Yukon College, Andrew A. Philipsen Law Centre, Kluane First Nations Community Buildings, Little Salmon Carmacks First Nation Administration Building, and Eliza Van Bibber School (Kishchik 2009). Fuel for the boiler for the Kluane First Nation buildings comes from wood chips from a local forest fire on First Nation land that left many trees dead and standing. The community of Dawson is in its first year of a biomass hot water heating system for the waste treatment plant using residues from a local mill (G. Cowman, pers. comm. Mar. 4, 2013).

5.12.5 Energy strategies, initiatives, and policies

Climate Change Action Plan (Government of Yukon 2012b)

The Yukon government set the target for its internal operations of capping GHG emissions at the 2010 level, reducing GHG emissions by 20% below the cap in 2015, and working to become carbon-neutral by 2020 (Government of Yukon 2012b).

Energy Strategy for Yukon (Government of Yukon 2009)

This strategy set out the Yukon government's energy policies and priorities. It demonstrates the government's support for a shift towards renewable energy sources including woody biomass. A priority action is to update and develop a policy framework for electricity that emphasizes efficiency, conservation, and renewable energy. The government commit-

ted to developing a policy that will facilitate the purchase of electricity from independent power producers and allow individuals to connect renewable energy sources to the grid. Along with supporting renewable energy projects in communities off the electrical grid to reduce diesel use, pilot studies will be conducted to assess the feasibility of renewable energy initiatives, and renewable energy sources will be promoted for heating and transportation. The strategy sets out the target of increasing renewable energy supply in Yukon by 20% by 2020.

Northern Premiers' Forum (Governments of Yukon, Northwest Territories and Nunavut 2009)

Here the Premiers of the three territories committed to developing an inventory of current and future renewable energy resources. The inventory describes the current use of renewable energy, outlines actions being taken, and describes policies under development to increase renewable energy use in the North.

5.12.6 Natural resource legislation

Forest Resources Act (Statutes of Yukon 2011b)

Forest harvesting in Yukon is regulated by the Forest Management Branch of the Department of Energy, Mines and Resources. Legislated requirements for forest resource management are set out in the *Forest Resources Act* and Regulations (Statutes of Yukon 2011b). These became effective in January 2011, replacing the Timber Regulation under the *Territorial Lands (Yukon) Act* (Statutes of Yukon 2003). The purpose of the act is to promote sustainable uses of forest resources in Yukon.

Forest harvesting (the "cutting and removal of any forest resource") may only be done in accordance with one of various forms of tenure agreements except for under a First Nations agreement, in emergencies, for personal sustenance, cooking or warmth, or under authority of the *Quartz Mining Act, Placer Mining Act,* or *Territorial Lands (Yukon) Act.* The tenure agreements are Timber Resource Licences, Fuel Wood Licences, Cutting Permits, Forest Resource Permits, and Woodlot Licences. Timber Resource Licences are issued for harvesting of timber for commercial purposes and can be up to 10 years, with one additional term, subject to approval. They are assignable, subject to approval. Fuel Wood Licences are required to harvest fuel wood for commercial purposes. The Licence can be for a maximum volume of 20 000 m^3. The maximum term is 5 years with renewal for an additional term, subject to approval. They are not assignable. Cutting permits may be issued to a commercial Licence holder with an approved site plan, and they are for a maximum term of 3 years. Forest Resource Permits are issued to harvest timber or fuel wood for personal use or harvesting of non-timber resources for commercial purposes. They can be issued for a maximum of 3 years and are not renewable or assignable. All Yukon residents may harvest up to 25 m^3 for personal home heating with a permit, free of charge. Woodlot Licences are currently not available but they will grant long-term access to sustainably manage small tenures within public forests.

5.12.7 Guides Forest Management Planning on public lands is guided by Forest Resource Management Plans, Timber Harvest Plans, and Site Plans. Forest Resource Management Plans are landscape-level plans that provide broad direction on where and why forest resource management activities should take place. They establish requirements for resource management, identify areas where harvesting may occur, and establish guidelines for harvesting within the identified areas. Strategies for monitoring implementation of the plans are also included. Timber Harvest Plans are landscape-level operational plans that guide the access and harvest of wood, and also identify environmental and social values and provide direction on addressing those values. In areas where regional Forest Resource Management Plans have been completed, Timber Harvest Plans reflect the strategic direction provided by these higher-level plans. Timber Harvest Plans: identify forest resources; describe ecosystems, forest resources, and forest health; provide an estimate of the type and volume of timber, appropriate harvest methods, and schedule for harvesting; and specify general locations for timber harvesting and access. Site Plans identify stand-level management activities and methods for harvesting. They identify the type and volume of timber intended for harvesting, harvest methods, and harvest schedule. Approved Site Plans must be in place before a cutting permit is issued.

Operational Standards

These are new management guidelines and standards developed by the Forest Management Branch under the Forest Resources Regulation (Statutes of Yukon 2011b) that identify operating procedures for forest harvesting and related activities. They are described below. They do not specifically address forest biomass harvesting.

Soil Conservation Standards and Guidelines (Government of Yukon 2012c)

Standards require that Site Plans include a description of the protective measures that will be used during harvesting and road construction and used to conserve soil productivity and hydrological functions. The Site Plan must specify the maximum percentage of the area in roads and landings (must not exceed 5% of the gross block area) and the maximum percentage of soil disturbance (including skid roads) within the net area to be reforested (must not exceed 5% of the net area to be reforested). Soils with a high hazard rating (as determined from a key) must be scheduled for winter/frozen harvest unless the Site Plan shows that risks can be managed (e.g., by the type of logging equipment used). Areas with soils with a very high hazard rating must be scheduled for winter/frozen harvest only. Guidelines include avoiding permafrost areas where possible and avoiding operating on slopes steeper than 30% with ground-based systems.

Wildlife Features Standards and Guidelines (Government of Yukon 2011b)

General guidelines include leaving snags standing where worker safety is not compromised and where their retention is consistent with site objectives. Standards include leaving no-disturbance buffers of specified radii around bear and wolverine dens, raptor tree nests, active stick nests, and active cliff faces used for nesting, and leaving beaver dams undisturbed

unless a permit to remove them is authorized. Wildlife trees must not be destroyed. Guidelines include leaving no-disturbance buffers around mineral licks and game trails.

Riparian Management on Streams and Lakes Standards and Guidelines (Government of Yukon 2011c)

The Standards specify that Riparian Management Areas (Reserve Zones plus Management Zones) be established around streams and lakes. Riparian Reserve zones are between 5–20 and 40–80 m in width for streams, depending on the stream class, and 20–40 to 40–60 m for lakes, depending on the size. Management Zones, measured from the outer edge of the Reserve Zone, are 20–30 to 60–120 m wide for streams and 20–60 to 80–140 m wide for lakes. Operations in the Management Zone must be conducted so as to maintain the integrity of the Reserve Zone. Guidelines include that roads should be located to avoid Riparian Management Areas except where required for stream crossings. Ephemeral draws require 5-m machine-free zones, directional falling, and limited skid crossings.

Wetlands Riparian Management (Government of Yukon 2011d)

The Standards specify that wetlands have Reserve Zone widths of 5–60 m and Management Zone widths of 40–140 m, depending on the wetland class. Operations in the Management Zone must be conducted so as to maintain the integrity of the Reserve Zone. Forest management activities may be allowed for bog, fen, and swamp wetlands. For all types of wetlands, winter use to access adjacent upland timber may be considered.

Historic and Archaeological Resources Standards and Guidelines (Government of Yukon 2011e)

Standards require that no disturbance is permitted to historic sites encountered during timber harvest operations and no objects may be removed from heritage sites. Yukon Heritage Resources may recommend a 0- to 100-m no-disturbance buffer around historic resources. In areas mapped as having high potential for historic resources, if activities are to occur that affect these resources, a historic resources impact assessment by a qualified archaeologist must be carried out prior to activities proceeding. If historic sites or resources are discovered during operations, the operator must immediately suspend operations and inform the Forest Officer and Yukon Heritage Resources of the location and nature of the resources that were found. Guidelines recommend that known historic and archaeological sites in the harvest planning area be mapped and their locations excluded from planned logging activities.

Incorporating Land User Interests Standards and Guidelines (Government of Yukon 2011f)

The objective here is to ensure that historic land user interests are maintained when forestry activities are carried out. The Standards specify that buffers must be maintained around cabin sites (usually 100 m for temporary-use cabins and 400 m around permanent residences). Forest harvesters must not knowingly cover, move, or destroy equipment used for land user activities that they find; shall ensure that road maintenance

does not limit recreation trail access across roads; and shall restore any recreation trails used by the land users along access routes if they have been damaged during harvesting/road building.

Landscape Planning Guidelines (Government of Yukon 2006)

These guidelines are designed to assist planners in achieving objectives in the Strategic Forest Management Plan and Implementation Agreement and apply to all forest harvesting and forest planning activities within the Champagne and Aishihik Traditional Territory. One of the goals of the Strategic Forest Management Plan is to "maintain the function and integrity of forest ecosystems by conserving forest productivity and biodiversity and related waters, soils, ecosystems and landscapes." The guidelines for achieving this goal include ensuring that coarse woody debris is incorporated in stand structure retention. The guidelines set out general requirements for harvesting beetle-killed wood and the same guidelines should be followed for fire-killed trees. These guidelines include retaining 25% of the stems in high wildlife areas. Where blowdown occurs in standing timber, it should be salvaged and utilized but with a first priority of protecting riparian values and water quality. Some post-fire forest is critically important for several wildlife species and a significant portion of the trees may need to be reserved. The Landscape Planning Guidelines also indicate that a maximum of 7% of the harvest block should be disturbed by skid trails, and, if this is exceeded, rehabilitation strategies should be employed.

5.12.8 Protected areas legislation In Yukon, land can be protected by any one of several pieces of legislation, including: *Parks and Land Certainty Act* (Statutes of Yukon 2002b), *Environment Act* (Statutes of Yukon 2002a), *Wildlife Act* (Statutes of Yukon 2002c), Inuvialuit Final Agreement, and Yukon First Nation Agreements. Federal legislation that applies in Yukon includes the *Canada Wildlife Act, Species at Risk Act,* and *Canada National Parks Act.*

About 5.9 million ha (12.3%) of Yukon has been designated as protected (Environment Canada, n.d. b) There are three National Parks that cover a total of 3.7 million ha. Other types of protected areas are Special Management Areas, many of which have been subsequently designated as a Territorial Park, National Wildlife Area, Habitat Protection Area, Ecological Reserve, or Wilderness Preserve. Territorial Parks are created and managed under the *Parks and Certainty Act,* which allows for withdrawal of land from these parks or revoking of park status. Industrial use is prohibited in Territorial and National Parks. Industrial activity is not always prohibited in Special Management areas. National Wildlife Areas are created and managed for wildlife conservation, research, and interpretation. There is one in Yukon, and industrial activities are not permitted.

6 FEDERAL POLICY

Although specific federal guidelines or policy for woody forest biomass harvesting do not exist in Canada, some higher-level strategies and policy do have a bearing on biomass harvesting. Specifically, there is an overall vision and commitment at the Federal (and Provincial) levels for sustainable forest management (SFM), which involves maintenance or enhancement of all forest attributes. Reference to renewable energy sources, including biomass, is found in some Federal strategic plans. As well, forest biomass (or at least CWD) is specifically mentioned in the requirements of the three internationally recognized forest certification programs under which Canadian forest managers can voluntarily certify their forest management practices (the Canadian Standards Association [CSA], the Forest Stewardship Council [FSC], and the Sustainable Forestry Initiative [SFI]). An overview of federal initiatives, strategies, and policies that have a bearing on forest biomass harvesting is briefly described below, followed by the relevant portions of the forest certification programs. These are not on-the-ground guidelines or legislation.

ecoENERGY Program (Government of Canada 2007)

This initiative was launched in 2007 to invest $1.48 billion to increase Canada's energy supply from renewable resources, which includes biomass, wind, low-impact hydro, geothermal, solar photovoltaic, and ocean energy. By March 2010, 99 contribution agreements worth a total of $1.4 billion were signed. By April of that year, 52 projects had been started, but less renewable energy than expected was produced; most of it was from wind power (Natural Resources Canada 2011c).

The Face of the Canadian Forest Industry: The Emerging Bio-revolution (Forest Products Association of Canada and FPInnovations 2011)

This report, released in February 2011 by the Bio-pathways partnership between Innovations, the Forest Products Association of Canada, and the Canadian Forest Service, with support from the Government of Saskatchewan, shows how the Canadian forest sector can be a major player in a $200 billion global market for bio-energy, biochemical, and biomaterials from non-traditional forest sector sources. It has been important in providing guidance for the transformation to this new potential (L. Stanley, pers. comm., May 9, 2012).

National Forest Strategy (2003–2008), A Sustainable Forest: The Canadian Commitment (Canadian Council of Forest Ministers 2008b)

The strategy provides an overarching national vision and framework involving a commitment to identify and address priorities for implementing Sustainable Forest Management (SFM). It is the fifth in a series of strategies that evolved and developed through extensive dialogue within the forest community. The trustee of the Strategy is the Canadian Council of Forest Ministers which consists of governing officials from all Canadian Federal, Provincial, and Territorial forest jurisdictions. Actions and goals for SFM in Canada are defined with the overall vision that "The long-term health of Canada's forest will be maintained and enhanced, for the benefit of all living things, and for the social, cultural, environmental

and economic well-being of all Canadians now and in the future." This overall commitment can be interpreted to mean that forest biomass harvesting must be sustainable and not reduce long-term forest health.

Canada Forest Accord (National Forest Strategy Coalition 1998)

The Canada Forest Accord complements the National Forest Strategy and repeats the statement of Canada's commitment to sustainable forest management. The goal of the Canada Forest Accord is similar to the vision of the National Forest Strategy: "To maintain and enhance the long-term health of our forest ecosystems, for the benefit of all living things both nationally and globally, while providing environmental, economic, social and cultural opportunities for the benefit of present and future generations."

United Nations Conference on Environment and Development (UNCED)

In 1992, UNCED was held aiming to bring countries together into a world-wide consensus and political commitment for sustainable development and environment co-operation, including the management, conservation, and sustainable development of all types of forests. The objectives related to policy included to "review and develop policies that support the best use of land and the sustainable management of natural resources, by not later than 1996" and planned activities included that "governments at the appropriate level, with the support of regional and international organizations, should ensure that policies and policy instrument support the best possible land use and sustainable management of land resources." Principles outlined in the Report of the United Nations Conference on Environment and Development (United Nations General Assembly 1992) included "Forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural and spiritual needs of present and future generations. These needs are for forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs, and for other forest products." Forest biomass would fall into the category of another forest product.

Convention on Biological Diversity (CBD) (United Nations 1992)

The CBD was opened for signature in June 1992 at UNCED, signed by 150 government leaders, and entered into force in December 1993. It was brought about as a tool to translate the principles from UNCED into reality. Its three main objectives were (1) the conservation of biological diversity, (2) the sustainable use of the components of biological diversity, (3) and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

Canadian Biodiversity Strategy (Minister of Supply and Services Canada 1995)

This strategy, released in 1995, is a guide to carrying out Canada's commitments under the CBD. It lays out a plan to (1) conserve biodiversity and promote sustainable use of resources, (2) improve the understanding and management of ecosystems, (3) develop incentives and legislation

to support the conservation of biodiversity, and (4) provide education about the need to conserve biodiversity. It was developed as a result of consultations conducted by Federal, Provincial and Territorial governments with industry, scientists, conservation groups, academics, and Aboriginal groups. It provides a framework for action to ensure that the productivity, diversity, and integrity of Canada's natural systems are maintained or enhanced.

Criteria and Indicators of Sustainable Forest Management (Canadian Council of Forest Ministers 2006)

The Canadian Council of Forest Ministers has established criteria and indicators to define and measure Canada's progress in SFM. They were first set in 1995 and updated in 1997, 2000, and 2003. The aim is to provide a common understanding of SFM. They identify the key ecological, social, and economic values that comprise sustainable forest management. The criteria represent forest values that Canadians want to enhance or sustain, and the indicators identify scientific factors to assess the state of the forests and measure progress over time. The broad criteria identified in 2003 are (1) biological diversity, (2) ecosystem condition and productivity, (3) soil and water, (4) role in global ecological cycles, (5) economic and social benefits, and (6) society's responsibility.

2008 Conference: The Scientific Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policies

This conference, hosted by Canada's Sustainable Forest Management Network, contributed to enhancing development of woody forest biomass harvesting policies in Canada, by providing an overview of information on existing research on biodiversity and site productivity considerations for biomass harvesting and existing knowledge gaps (Titus et al. 2010).

Forest certification programs

The three voluntary forest certification programs used in Canada all set obligations above and beyond policy regulations, and include requirements for maintenance of soil productivity, water resources, wildlife habitat, species diversity, conservation of biological diversity, and ensuring that harvest levels are sustainable. They are not legal requirements for forest companies but identify a company's commitment to SFM. Globally, the Canadian certification programs are endorsed by independent nonprofit certification programs that have standards, criteria, and objectives that governments around the world view as the basis for SFM. CSI and FSI are endorsed by the Programme for Endorsement of Forest Certification, and the national FSC standards by FSC International. Woody forest biomass is addressed in a general way in most of these programs.

1. Canadian Standards Association (Canadian Standards Association 2010)

The CSA advocates "maintenance and enhancement of long-term health of forest ecosystems, while promoting ecological, economic, social, and cultural opportunities for the benefit of present and future generations." Performance requirements for participants include criteria for biological

diversity, ecosystem condition and productivity, soil and water, and role in global ecological cycles:

- Section A.6.3 states "An example of a habitat element that requires special attention in the design and implementation of forest treatments is deadwood, whose snags and downed logs provide habitat for a diverse range of forest species"; and
- Section A.6.3.2.4 (biomass utilization) refers to the use of forest biomass (including dead trees, CWD, and fine materials) as a contemporary issue in sustained forest management in Canada, and encourages subsequent discussions to "examine future expectations for biomass use with emphasis on the ecological and cultural impacts of biomass removals." This section states that "if the organization intends to remove biomass, it should develop clear operational guidelines for the sustainable removal of biomass from forest ecosystems." This implies that the licensee should take responsibility for sustainable forest biomass harvesting.

2. Forest Stewardship Council (Forest Stewardship Council 2004, 2005, 2008, 2011)

The FSC has separate requirements for four regions of Canada (British Columbia, Boreal, Maritimes, and Great Lakes–St. Lawrence):

- Boreal Forest Standards require that ecological functions and values remain intact, be enhanced, or be restored, including "forest regeneration and succession, genetics, species and ecosystem diversity, and natural cycles that affect the productivity of the forest," and "harvesting, site preparation and forest operations should be undertaken in a manner that avoids site and soil damage and encourages protection of the site." Management of woody biomass is not specifically mentioned;
- The standards for British Columbia, the Maritimes, and Great Lakes–St. Lawrence region all require that "Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and by doing so, maintain the ecological functions and the integrity of the forest";
- British Columbia Standards require that "structural components, including at a minimum canopy complexity, live wildlife trees, snags and CWD are maintained or restored to quantities that are comparable with RONV [range of natural variability]." Forest management must "maintain soil fertility and natural soil processes by limiting detrimental soil disturbance to less than 7% of the timber harvesting land base, and limiting detrimental soil disturbance to less than 10% of the timber harvesting land base where there are off-setting environmental, cultural or other non-economic benefits for the increases over 7% and the benefits are explained in a written rationale";
- Maritimes Standards require that "CWD in the form of large fallen trees, large logs and snags of various sizes is maintained in each stand sufficient to maintain the wildlife habitat attributes and forest ecosystem productivity through the regeneration period" and "Harvesting, site preparation, and other forest operations should be undertaken in a manner that minimizes site and soil damage and soil nutrient loss"; and

- Great Lakes–St. Lawrence Region: No specific reference to CWD management or maintaining soils.

3. Sustainable Forestry Initiative (Sustainable Forestry Initiative 2010)
- Same requirements for forest management regardless of the final product, whether it is solid wood building products, paper products, or bioenergy feedstock; and
- Objectives include ensuring long-term forest productivity, carbon storage, and conservation of forest resources, and conserving and promoting biological diversity and conservation of forest plants and animals. Program participants must implement forest management practices to protect and maintain forest and soil productivity (seven ways to do this are listed) and must implement stand- and landscape-level measures that promote a diversity of types of habitat and successional stages, and conservation of forest plants and animals (10 ways to do this are listed). One of these ways is through "development and implementation of criteria, as guided by regionally appropriate best scientific information, to retain stand-level wildlife habitat elements, such as snags, mast trees, down woody debris, den trees and nest trees."

7 SUMMARY

This report summarized policies, including legislation, regulations, and guidelines, that relate to forest biomass harvesting in Canada. Forest biomass harvesting can include removal of roadside residues from blocks previously logged, removal of woody debris off the site, salvage of unmerchantable dead stands (e.g., fire or insect impacted), harvesting of stands traditionally considered unmerchantable (e.g., too small), harvesting of silviculture residues (e.g., from thinning), or harvesting of purpose-grown plantations (e.g., hybrid poplars). The report focussed on the first three since this is where much (but not all) of the attention is currently focussed and the most information is available.

Policy relating to forest biomass harvesting was not found in a central document for most provinces. An exception is New Brunswick, which developed a policy in 2008 especially for forest biomass harvesting. Ontario also has a policy addressing forest biomass harvesting but it is not as detailed as New Brunswick's. Prince Edward Island has biomass guidelines that differentiate between projects with no public investment and projects with public investment such as grants or loans, silvicultural incentives, or green credits or certification from government. Information about the policies in place for the other provinces and territories is not readily available without speaking with experts in the field, and even then just a few guidelines specific to forest biomass harvesting seem to exist. Up-to-date information about policies is not available publicly online, and even information about biomass harvesting operations that are going on is scarce and scattered for most provinces and territories. Provincial policies are in various stages of development and generally not ready for release in an official format. Biomass harvesting policies do not exist at the Federal level.

Policies outside of Canada were looked at to see what kinds of things have been included in forest biomass harvesting policies, and this helped guide the type of information to search for. Relevant operational on-site guidelines that were found mainly related to removal of woody debris, soils, site productivity, wildlife, biodiversity, and riparian area management. Information about skidding recommendations was easily found and would be highly relevant to biomass harvesting, although disturbance levels from increased activity on logged areas may be higher than from conventional logging. Site-specific guidelines as to which ecosystems are suitable for forest biomass harvesting are not readily available (but potentially may exist in internal documents), except for the Canada-wide agreement that woody debris should be retained on poor sites (thin, dry, and/or coarse-textured soils). Biomass allocation procedures were described for each province although this information was quite scattered. Policies setting out requirements for sustainable forest management are widespread and were summarized because of the implication that forest biomass harvesting must be sustainable along with other forestry activities. Plans and strategies promoting increased use of renewable energy sources were briefly described because they may affect expansion of the bioenergy industry, but they may be of minimal interest to readers looking for operational guidelines for biomass harvesting.

In general, forest management guidelines were developed for conventional logging, before biomass harvesting was done, and some may question whether or not they are adequate, given the increased level of nutrient removal, site disturbance, wildlife habitat loss, and other consequences resulting from biomass removal. More explicit forest biomass harvesting guidelines can be expected in the near future for several provinces; meanwhile, operations for most provinces and territories will largely operate under a few basic rules and existing natural resource legislation and guidelines.

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PERSONAL COMMUNICATIONS

Andre Arsenault – Forest Ecologist, Natural Resources Canada – Canadian Forest Service, Atlantic Forestry Centre, Newfoundland and Labrador

Bryce Bancroft – Symmetree Consulting Group, Victoria, B.C.

Bill Clarke – Department of Natural Resources, Newfoundland and Labrador

Greg Cowman – Forester, Energy, Mines and Resources, Government of Yukon, Whitehorse, Yukon

Bill Crins – Senior Program Co-ordinator, Resource Conservation, Parks and Protected Areas Policy Section, Natural Heritage, Lands and Protected Spaces Branch, Ontario Ministry of Natural Resources

Nancy Densmore – Biodiversity Specialist, B.C. Ministry of Forests, Lands and Natural Resource Operations, Victoria, British Columbia

Jane Epp – Forest Development Officer, Manitoba Conservation and Water Stewardship, Forestry Branch, Winnipeg, Manitoba

Sean Greene – Forest Engineer, Department of Natural Resources, Newfoundland and Labrador

Brad Harris – Senior Timber Tenures Forester, B.C. Ministry Forests, Lands and Natural Resource Operations, Victoria, B.C.

Faron Knott – Corner Brook Pulp and Paper, Newfoundland

Tom Lakusta – Manager, Forest Resources, Government of the Northwest Territories, Department of Environment and Natural Resources, Hay River, N.W.T.

Eric Lui – Business Development Specialist, Manitoba Agriculture, Foods and Rural Initiative

Dave Morris – Research Scientist, Centre for Northern Forest Ecosystem Research, Ontario Ministry of Natural Resources

Dave Patterson – Biofuels, Bioenergy and Bioproducts Specialist and Senior Forest Policy Advisor, Forest Industry Development, Alberta Environment and Sustainable Resource Development

Michael Ryan – Research Ecologist, B.C. Ministry Forests, Lands and Natural Resource Operations, Kamloops, B.C.

Robert Schuetz – President, Industrial Forest Service Ltd, British Columbia

Teddy Stalker – Forest Extension Specialist, Nova Scotia Department of Natural Resources

Larry Stanley – Forestry Development Manager and Bioenergy Expert, Forestry Development Branch, Minerals, Lands and Resource Policy Division, Saskatchewan Ministry of the Economy

Evelyne Thiffault – Research Scientist, Laurentian Forestry Centre, Canadian Forest Service, Quebec

Peter Uhlig – Ecologist, Inventory, Monitoring and Assessment Section, Ontario Ministry of Natural Resources

APPENDIX Summary of forest biomass harvesting policy by province or territory

Jurisdiction	Policy
British Columbia	• No specific forest biomass harvesting policy, except for revision of FPPR in support of Fibre Recovery Tenures • Forest companies have rights to all biomass on the blocks for which they have cutting permits, and may remove as much as they wish within the CWD retention requirements under the *Forest and Range Practices Act*, which are minimal • No special licence or agreement for biomass harvesting is required for these primary harvesting companies • As of 2012, there are new Fibre Recovery Tenures and related changes in regulations in the *Forest Act*, *the Forest and Range Practices Act*, and the *Wildfire Act* • From this, Forest Planning and Practices Regulations underwent revision to the soil disturbance provisions (section 4.1) • Many documents exist containing non-legal recommendations for retention of CWD (but generally not fine debris) on logged blocks
Alberta	• No specific forest biomass harvesting policy • Harvest residues are the property of the timber disposition holders who harvested the timber • Timber disposition holders who harvest woody biomass are required to meet the existing requirements for cleanup and reforestation as required for the timber disposition • Harvest residues become the property of the Crown if the timber disposition holder does not utilize them within 2 years of logging • Ground Rules set requirements for all harvesting operations
Saskatchewan	• No specific forest biomass harvesting policy but is being actively developed • Legislated manuals and Forest Management Agreements set requirements for forestry activities
Manitoba	• No specific forest biomass harvesting policy • The *Forest Act* and its regulations specify what merchantable timber is and the amount of material that can be left behind • Unmerchantable woody biomass can be harvested when requested, providing there is authorization • Biomass opportunities are reviewed on a site-by-site basis and instructions are detailed in the Timber Sale Agreements and permits • Manitoba Conservation guidebooks set out BMPs for forestry, which become requirements when part of Work Permits
Ontario	• The Ontario Forest Biofibre Policy was released in 2008 • Any use of forest biofibre is regulated through the forest management planning process, and all policies and standards that apply to traditional wood harvesting must be complied with • The standards and guidelines for forest biomass harvesting are covered in Section 6.2 of the Stand and Site Guide (2010), which clearly defines what may and may not be harvested • The right to use forest biomass is allocated through current sustainable forest licences but there has recently been a competition where additional allocations specific to biomass have been given • A number of planning manuals and silviculture guides set guidelines for forestry activities
Quebec	• No specific forest biomass harvesting policy • In 2015 new forest management regulations will be introduced, which may include more specific requirements for forest biomass harvesting. • Guidelines relating to woody biomass harvesting are decided at the regional rather than provincial level and are based on local concerns and developed by a committee that includes a variety of groups • There is no province-wide policy preventing whole-tree harvesting • Regional guidelines specify those sites where it is forbidden to return to a site and harvest the biomass once logging is completed • Regulation respecting standards of forest management for forests in the public domain sets out detailed requirements for forest management activities
Nova Scotia	• Nova Scotia developed a biomass harvesting policy but because of a moratorium on using slash for electricity production it is no longer in effect • The Code of Forest Practices contains mandatory guidelines for forestry activities on Crown land, which are also encouraged for private land owners.

APPENDIX Continued

Jurisdiction	Policy
New Brunswick	• New Brunswick has a biomass harvesting policy for Crown land that has been in effect since 2008 • Eligibility of sites for biomass harvesting focusses on soils and maintenance of site productivity
Prince Edward Island	• Biomass guidelines require pre-harvest management plan and harvests that comply with standards in Ecosystem-based Forest Management Manual • In clearcut harvests, whole-tree harvesting is not allowed • In commercial thinning and non-clearcut harvesting, whole-tree harvest is permitted but stumps must be left on site • All biomass harvest sites must be mapped and maps filed with government
Newfoundland and Labrador	• No specific forest biomass harvesting policy • Current guidelines are to not practise full-tree harvesting, to leave tops and limbs on site, and to retain a certain number of trees per hectare for wildlife and future woody debris recruitment • Guidebooks contain requirements for forestry activities (e.g., logging near waterbodies, skidding recommendations)
Northwest Territories	• There is no specific forest policy relating to forest biomass harvesting • N.W.T. *Forest Management Act* provides for five trees < 5 m in height per person per year for personal use including fuelwood • Canadian Charter of Rights and Freedoms states that First Nations people without settled land claims have subsistence rights that include tree cutting
Yukon	• There is no specific forest policy relating to forest biomass harvesting • Recent Operating Standards identify procedures for forest harvesting and related activities • Older standards (Department of Indian Affairs and Northern Development 1999) specify that scattered pieces of coarse woody material and small piles of woody debris should be left within cutblocks for small mammal habitat